

METAL FREE PROSTHODONTICS

¹ Shiva Shankar M ¹ Professor and Head
² Nitesh Rai ² Associate Professor
³ Digvijaya Patil ³ Post graduate student

^{1,2,3} Department of Prosthodontics, Krishnadevaraya College of Dental sciences, Bangalore, India

ABSTRACT

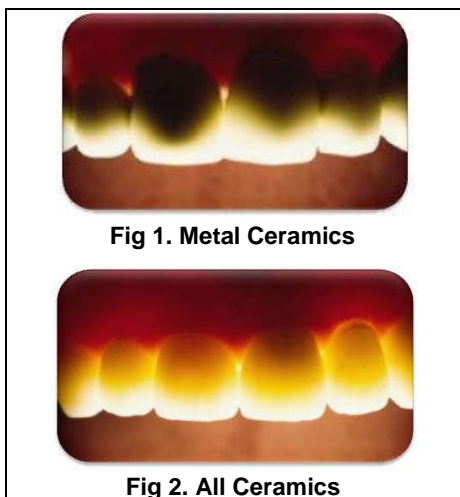
Metal free or All –ceramic restorations are the term for restorations consisting solely of ceramics without any metal support . They are highly esthetic . This article reviews some of the common metal free ceramics and their application

KEYWORDS: Metal ceramic, Alumina, Zirconia

INTRODUCTION

Metal free or all –ceramic restorations are the term for restorations consisting solely of ceramics without any metal support. As early as 1990 of the estimated 35 million crowns placed by dentists, more than 71% had ceramic as one of the components. These ceramics are abrasion resistant, have light-transmitting and light fracturing properties. They are absolutely colour stable, and enable invisible transition of the restoration margin into the dental tissues². They are relatively chemically inert and are bio neutral in comparison to other restorative materials, they are insoluble and therefore biocompatible².

The quest of the dentists to fulfil the needs of the patients aesthetic demands of natural looking restoration of their lost tooth has propelled the research and growth of All ceramics in dentistry. (Fig.1 and Fig.2)



Brittleness is the characteristic property of the ceramic and when compared to metal it has low flexural strength and

fracture strength. They are resistant to high compressive stress but susceptible to tensile forces. Inlays, onlays, veneers, crowns, and fixed dental prosthesis (FDP) can be fabricated by all-ceramic materials⁷. (Fig .3)

CLASSIFICATION All Ceramic materials used for Dental restorations can be classified broadly as (Fig.4)

Lithium Disilicate

The Empress II and E max system uses a lithium-disilicate glass core material. The framework is fabricated with either the lost-wax and heat-pressure technique or is milled out of prefabricated blanks. The flexural strength ranges from 300-400 MPa¹. Fracture toughness (KIC) ranges between 2.8 and 3.5 MPa /m^{1/2}³, which describes the resistance of brittle materials to the catastrophic propagation of flaws under an applied stress. These restorations be etched and adhesively luted to enhance their strength and longevity.

Glass-infiltrated Alumina

The In-Ceram Alumina system was the first restorative system introduced for the fabrication of 3-unit anterior FDP's, which uses high temperature sintered-alumina glass-infiltrated copings for all-ceramic crowns. It can be fabricated with either the slip-casting technique or milling out of prefabricated partially sintered blanks. The flexural strength ranges from 236 to 600 MPa^{4,5}, and the fracture toughness ranges between 3.1 and 4.61 MPa/m^{1/2}^{3,13}.

Densely sintered high-purity Aluminium-oxide

The Procera All Ceram system uses a densely sintered high-purity aluminium-oxide as the core material. Flexural strength of the framework material demonstrated a range from 487 to 699 MPa^{4,5}. For this core material the fracture toughness ranges between 4.48 to 6 MPa/ m^{1/2}¹³.



Glass-infiltrated Alumina with 35% partially stabilized Zirconia

Slip casting technique or millings out of prefabricated partially sintered blanks are used to fabricate the framework. The results of various types of tests measuring the flexural strength of the core material have been reported to range from 421 to 800 MPa^{4,5} and fracture toughness ranges between 6 and 8 MPa/m^{1/2}³. In terms of translucency, the In-Ceram Zirconia core is as opaque as a metal-alloy core. Therefore, In-Ceram Zirconia is not recommended for fabricating anterior all-ceramic FDP's, where the translucency of the all-ceramic core materials is a major factor in enhancing an aesthetic result.

Yttrium Tetragonal Zirconia Polycrystals (Y-TZP) based

The most recent core materials for all-ceramic FDP's which has revolutionized All ceramic restorations is the yttrium tetragonal zirconia polycrystals (YTZP) based materials. Yttrium oxide is a stabilizing oxide added to pure zirconia to stabilize it at room temperature and to generate a multiphase material known as partially stabilized zirconia⁶. The high initial strength and fracture toughness of Y-TZP result from the physical property of partially stabilized zirconia. Tensile stresses acting at the crack tip induce a transformation of the metastable tetragonal zirconium oxide form into the monoclinic form. This transformation is associated with a local increase of 3% to 5% in volume. This increase in volume results in localized compressive stresses being generated around and at the tip of the crack which counteract the external tensile stresses acting on the fracture tip. This physical property is known as transformation toughening⁶. In vitro Studies have demonstrated a flexural strength of 900 to 1200 MPa and fracture toughness of 9-10 MPa/ m^{1/2}, which is almost double the value demonstrated by alumina-based materials, and almost 3 times the value demonstrated by lithium disilicate-based materials. Y-TZP FDP's under static load demonstrated fracture resistance of more than 2000 N. Because of such high values they are being used for Posterior FDP's replacing the traditional metal cores. Zirconia is also the most biocompatible material and it is not new in the medical field, they have used as Ball head replacement for Knee joints successfully. The advent of CAD CAM in dentistry has led to the increased use of this material.

Developments in ceramic core materials have allowed more widespread application of all-ceramic restorations over the past 10 years.

CLINICAL RECOMMENDATIONS

Leucite and feldspathic glass ceramics are indicated for onlays, three quarter crowns, and veneers, but their strength limits their use to complete coverage crowns in the anterior segment, only¹⁰. Lithium-disilicate glass ceramics can perform successfully in the posterior segment for single crowns and 3-unit FDPs in the anterior area¹⁰. Zirconia has superior mechanical properties as a core material for posterior crowns and FDPs, implant abutments, and implant-supported restorations. The stronger ceramic core materials can be rather opaque and this may limit their application when a high degree of translucency is required. But again the newer Zirconia are more translucent. Optimal thickness of alumina and zirconia cores and their respective veneering materials is critical for esthetics and strength to support occlusal forces. Surface treatment combining etching and a silane coupling agent provides the highest bond strength of composite resin cement to feldspathic ceramics and increases the fracture resistance of the restoration. Zirconia-based restorations can be cemented conventionally. Materials with increased translucency that are customized through characterizing or layering techniques will best be able to match natural tooth structure.

PATIENT SELECTION AND LIMITATIONS

To facilitate patient selection for all ceramic FDPs, the clinician must confirm adequate prospective connector height for the framework material and veneering ceramics prior to determining the restoration of choice^{8,9}. A 4-mm clinical measurement with periodontal probe from interproximal papilla to the marginal ridge of the prospective abutment for posterior FDPs, or to the incisal embrasure for anterior FDPs, indicates adequate connector height for most contemporary all-ceramic systems. The concentration of heavy stresses in the connector area increases the risk of catastrophic fracture^{8,9}. Prospective abutments exhibiting increased mobility should not be used as a foundation for all-ceramic

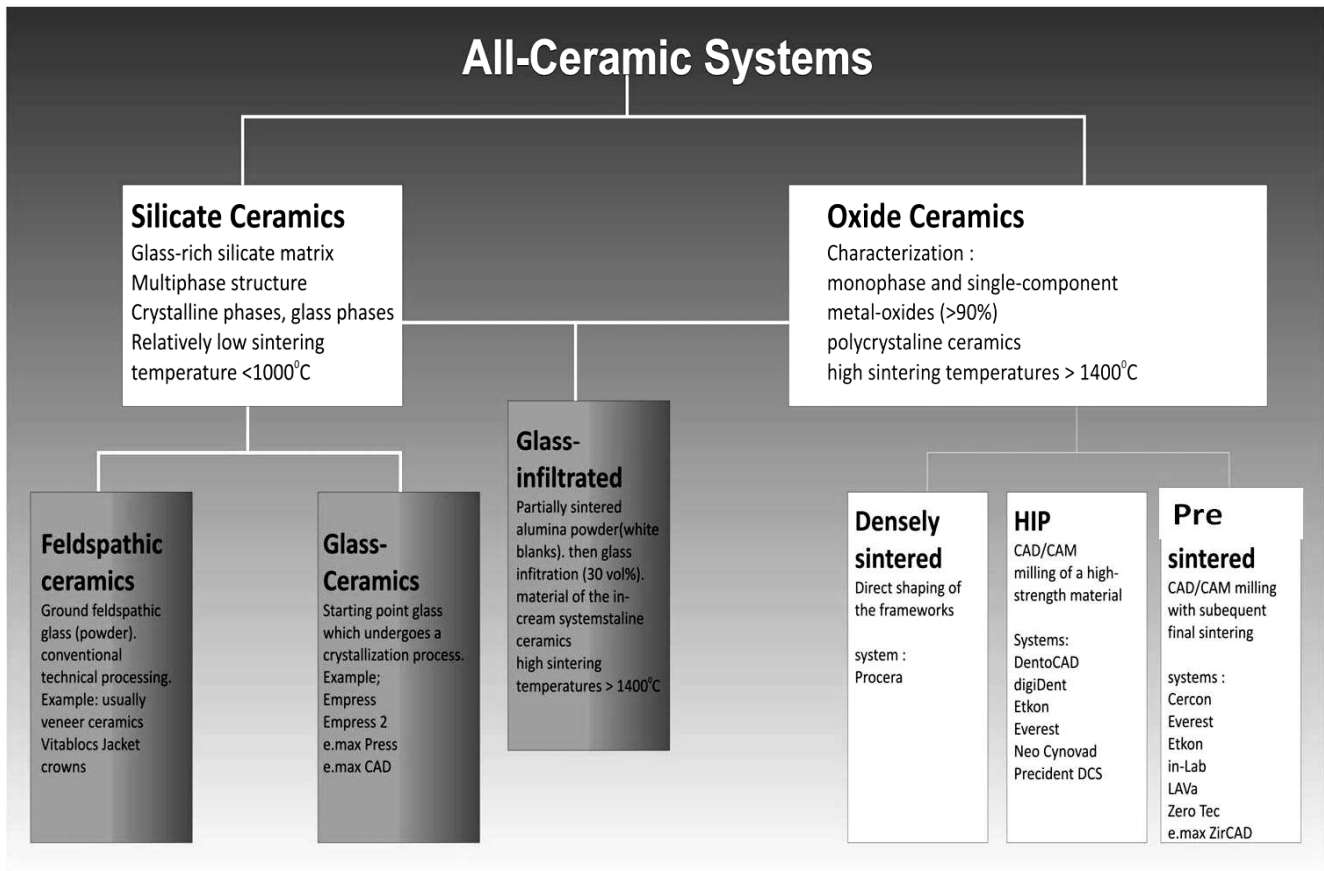
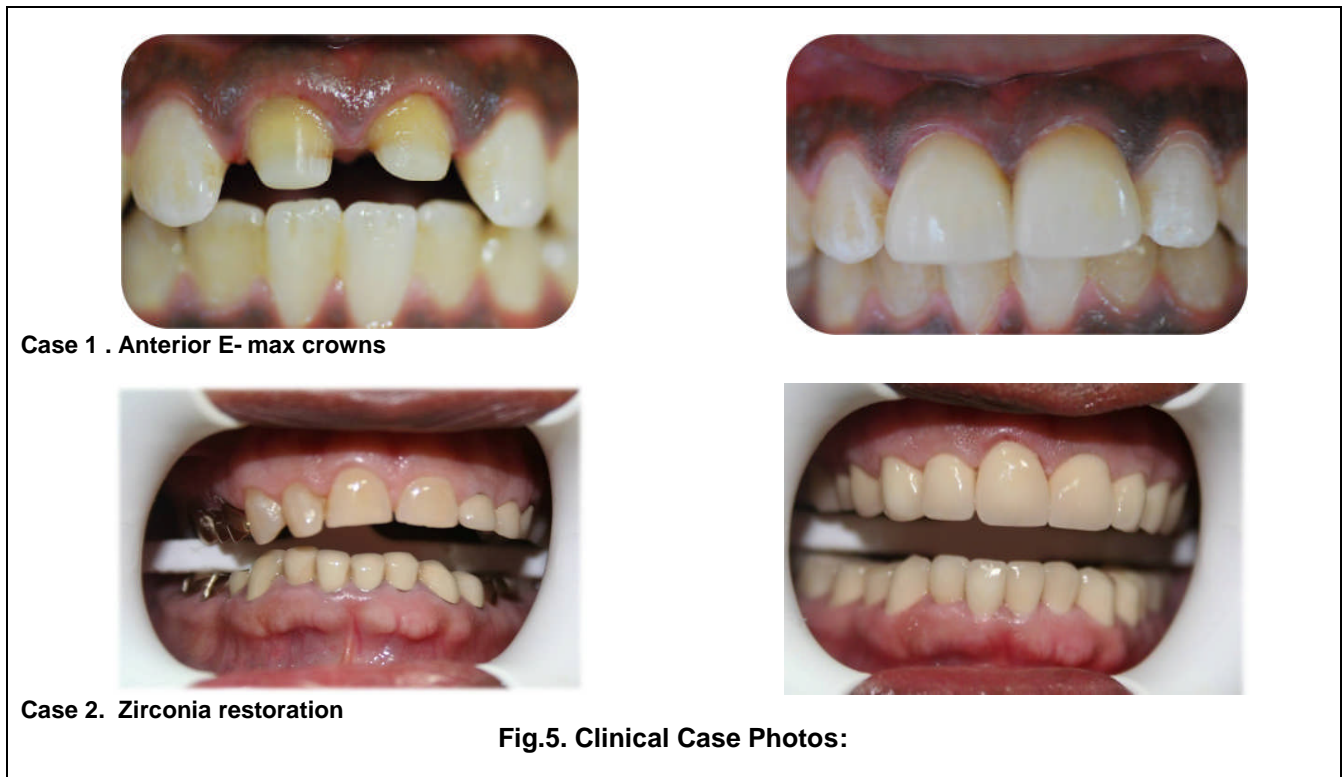


Fig 4. Classification of metal free ceramics



FDPs. The use of all-ceramic FDPs with a cantilever design is questionable because of the possibility of developing heavy stress at the connector as the pontic acts as a lever that is depressed under occlusal forces.

Finally, heavy bruxers who exhibit severe Parafunctional activity that cannot be controlled may not be candidates for all-ceramic FDPs¹. An occlusal heat-processed acrylic resin appliance to protect the teeth and restorations during the night should be considered.

CONCLUSION

Successful application of these materials will depend upon the clinician's ability to select the appropriate material, manufacturing technique, and cementation or bonding procedures, to match intraoral conditions and aesthetic requirements.

References:

1. Raigrodski AJ. Contemporary materials and technologies for all-ceramic fixed partial dentures: A review of the literature. *J Prosthet Dent* 2004; 92:557-62. doi:10.1016/j.prosdent.2004.09.015
PMid:15583562
2. Kelly JR, Nishimura I, Campbell SD. Ceramics in dentistry: Historical roots and current perspectives. *J Prosthet Dent* 1996; 75, 18-32. doi:10.1016/S0022-3913(96)90413-8
3. Quinn JB, Sundar V, Lloyd IK. Influence of microstructure and chemistry on the fracture toughness of dental ceramics. *Dent Mater* 2003; 19:603-11. doi:10.1016/S0109-5641(03)00002-2
4. Giordano RA II, Pelletier L, Campbell S, Pober R. Flexural strength of infused ceramic, glass ceramic and feldspathic porcelain. *J Prosthet Dent* 1995; 73:411-8. doi:10.1016/S0022-3913(05)80067-8
5. Seghi RR, Sorensen JA. Relative flexural strength of six new ceramic materials. *Int J Prosthodont* 1995; 8:239-46. PMid:10348592
6. Piconi C, Maccauro G. Zirconia as a ceramic biomaterial. *Biomaterials* 1999; 20:1-25. doi:10.1016/S0142-9612(98)00010-6
7. Raigrodski AJ. Contemporary all-ceramic fixed partial dentures: a review. *Dent Clin North Am* 2004; 48:531-44. doi:10.1016/j.cden.2003.12.008
PMid:15172615
8. OhW, Gotzen N, Anusavice KJ. Influence of connector design on fracture probability of ceramic fixed-partial dentures. *J Dent Res* 2002; 81:623-7. doi:10.1177/154405910208100909
PMid:12202644
9. Oh WS, Anusavice KJ. Effect of connector design on the fracture resistance of all-ceramic fixed partial dentures. *J Prosthet Dent* 2002; 87:536-42. doi:10.1067/mpr.2002.123850
PMid:12070517
10. Conrad HJ, Seong W and Pesun JI. Current ceramic materials and systems with clinical recommendations: A systematic review. *J Prosthet Dent* 2007; 98:389-404. doi:10.1016/S0022-3913(07)60124-3
11. Antonson SA, Anusavice KJ. Contrast ratio of veneering and core ceramics as a function of thickness. *Int J Prosthodont* 2001; 14(4):316-20
PMid:11508085
12. Griggs JA. Recent Advances in Materials for All-Ceramic Restorations. *Dent Clin N Am* 51 (2007) 713-727. doi:10.1016/j.cden.2007.04.006
PMid:17586152 PMCID:2833171
13. Wagner WC, Chu TM. Biaxial flexural strength and indentation fracture toughness of three new dental core ceramics. *J Prosthet Dent* 1996; 76: 140-4. doi:10.1016/S0022-3913(96)90297-8
14. Russell Giordano. Materials for chair side CAD/CAM-produced restorations. *JADA* 2006; 137(9):14-21.

Corresponding author

Dr. Shiva Shankar M

Professor and Head
Department of prosthodontics
Krishnadevaraya College of Dental
Sciences,
Bangalore-India.

E-mail: sshankar99@yahoo.com

Phone No: +91 9886701568