REVIEW ARTICLE

CONTEMPORARY ALL-CERAMIC SYSTEMS, PART-2

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Summary: Current all-ceramic materials offer a accepted level of fracture resistance, fit and aesthetics. High fracture resistance recommends it to be a material to support fixed partial denture (FPD) in a stress bearing area with clinical success. This part of the present literature review covers the success rate, selection criteria of all ceramic systems, cementation technique, finishing and polishing. In vitro and in vivo studies of new high strength ceramics were well documented. Data suggest that single crowns in the anterior and posterior region are more predictable than bridges. Well-studied long-term success rate for FPDs are very limited.

Key words: *All-ceramic; Success rates; Luting agents; Polishing*

Advantages of all-ceramics over metal ceramic systems

- Aesthetic advantages of all-ceramic systems are proved by replacing the light blocking metal substructure by more opaque high strength ceramic.
- Wide range of patients' tooth shades ('value' in Munsell scale) can be satisfied.
- Because of colour, finish line can be at gingival margin or 0.5 mm subgingival without compromising aesthetics.
- All-ceramic systems have reduced thermal conductivity, resulting in less thermal sensitivity and pulpal irritation.
- Because of lesser accumulation of bacteria on ceramic surfaces, it can be used over implants in the sub gingival area (20).
- More biocompatible.
- Emergent profile of all-ceramic crowns is less likely to be over-contoured.

In vitro and in vivo data

All-ceramic crowns/bridges

The metal ceramic system is the longest studied FPD system; it would be better to compare the all-ceramic system with the data of metal ceramic system. Walton's retrospective study of 515 metal-ceramic FPDs showed the cumulative survival rate of FPDs was 96 % for 5 years, 87 % for 10 years, and 85 % for 15 years. Reported modes of failure for metal ceramic FPDs were tooth fracture (38 %), periodontal breakdown (27 %), loss of retention (13 %), and Caries (11 %) (24). In literature review there are 5 ceramic systems which were studied in detail. They are:

a. Glass infiltrated alumina (In-ceram alumina, Vita).
b. Leucite-reinforced glass (Empress, Ivoclare),
c. Glass infiltrated magnesium aluminate spinell (In ceram spinell, Vita),
d. Poly crystalline alumina (Procera, Noble Biocare)
e. Zirconium- oxide Ceramics

Tab. 1: Comparison of Success Rates of Different Systems.

System	No of units	Follow-up years	Success %
In-Ceram spinell[9]	40 Anterior		97.5 %
Leucite-reinforced glass (Empress, Ivoclar)[8]	30 units FPD	2 years	93 %
In-Ceram Alumina[12]	80 Crowns	4 years	95 %
Densely sintered	87 crowns	5 years	97.7 %
allumina (Procera)[17]		10 years	92.2 %
Lava Zirconium oxide (3M-ESPE)	Insufficient data		

A reported failure rate appears to be lower for anterior crowns than molar crowns. The least amount of failure was reported for posterior restorations manufactured by high strength all-ceramic systems (All Ceram alumina; Procera, In- Ceram Alumina; Vita). Documented data is in agreement with reported data of metal ceramic systems. Long term follow up of newer Zirconium system results are widely expected.

Selection criteria

An ideal ceramic material for the fabrication of artificial replacement should allow for control of substrate colour (hue, chrome and value) and translucency. The substrate translucency is one of the most important factors in controlling the final aesthetics (15). Transmission of light by the substructure directly influences the final appearance of veneer porcelain. The translucency of ceramics is mostly dependent on light scattering. The light passing through ceramics is "intensely scattered and diffusely reflected", thus the material will appear translucent (13).

During the shade selection of natural tooth, the gingival third and body of the natural tooth are evaluated for the 'opacity'. Heffernan et al (14) suggested that teeth with low value and high translucency could be restored with Empress, In-Ceram Spinell, or Empress 2. Teeth with average value and translucency restoration with In-Ceram Spinell, Empress, and Empress 2 would be better. More opaque, high value teeth could be restored with more opaque substrates such as In-Ceram alumina or In-Ceram Zirconia.

Newer high strength oxide based ceramics (e.g., Densely sintered alumina Procera®) can produce a core with a different colour ('white' and 'translucent') and thickness (standard 0.6 mm, thin 0.4 mm) with different optical properties. This variation can be helpful to mask the discoloured teeth, or to deal with the minimal occlusal clearance, without compromising the strength of the ceramic material. Y-TZP (19, 3) based material, when used as substructure for Crowns or Bridges, can be coloured into one of seven shades (Vita-Lumen shade guide) after milling. The ability to control the shade of the core can also eliminate the need to veneer the lingual and gingival aspect of the connectors in cases with interocclusal limited clearance. Furthermore, the palatal aspect of anterior crowns and bridges can be fabricated from core material only.

Cementation and bonding

The study of fracture-surface analysis of failed all-ceramic restorations shows that failure originated from internal or cementation surface (22, 16). The longest studied first glass-ceramic crowns (Dicor, Dentsply) showed a higher survival rate when etched and luted with low viscosity resin cements. In 1995, a survey of the American Academy of Esthetic Dentistry reported resin cement to be the most popular cement used for cementing all-ceramic crowns, about 64 % (7). The final colour of all-ceramic material is determined by the thickness of porcelain, thickness and colour of the underlying tooth structure (23). Barath's spectrophotometer analysis of all-ceramic materials confirmed the earlier studies that the luting agents, in combination with background shade, influence the final colour of the restoration (2). Only dark ceramics and opaque luting agents can mask the dark background colour of the tooth.

Silica based ceramics, such as feldspathic porcelain, and glass ceramics are indicated for laminate veneers, veneering of high strength all-ceramic and inlays and onlays. Studies show that the use of adhesive composite resin for cementation increases the fracture resistance of these restorations and abutment teeth too. Lucite reinforced feldspathic porcelain (e.g. IPS Empress; Ivoclar-Vivadent, Schaan, Liechtenstein) and Lithium-disilicate glass-ceramic core (e.g. IPS Empress2; Ivoclar-Vivadent, Schaan, Liechtenstein) showed increased fracture strength and are used in posterior and anterior teeth by using resin-bonding technique. Because of the "selective etchability" of Lucite more than surrounding ceramic, it is possible to achieve good micro-mechanical bonding with resin cement. New popular high strength oxide based ceramic materials Aluminum oxide (Procera® All Ceram, Nobel Biocare AB, Gothenburg, Sweden), Zirconium oxide Ceramic (e.g., Procera® All-Zirkon, Lava® 3M ESPE, St Paul, MN, USA, Cercon® Dentsply Ceramco) cannot be etched to such extent to get good micro-mechanical retention(4).

A densely sintered, high purity aluminum oxide ceramic (e.g. Procera® AllCeram) surface cannot be altered by application of 9.6 % hydrofluoric acid or 37 % of phosphoric acid. Airborne particle abrasion with micro etcher (50 µm) Al_2O_3 at 2.5 bar pressure achieved higher bond strength (19). Zirconium oxide ceramics don't contain a specific group to bond to siliniziation agents. Therefore, zirconia has to be sandblasted or coated with particles (3M™ ESPE™ Rocatec system). Through this treatment with tribochemical reaction, the surface of zirconia is coated with a small particle of "Silicium oxide". This can bind well to silinization agents and establishes chemical bonding to the adhesive resin cement. Kern et al. showed phosphate-modified resin cement [Panavia 21; Kurary, Tokyo Japan (17), Superbond C&B Sun medical, Shiga, Japan (8) had good bond strength to Zirconium oxide ceramic after airborne particle abrasion.

Finishing and polishing

Adjustments of ceramic crowns or bridges are most commonly encountered during delivery of metal ceramic and all-ceramic crowns. Technicians and dentists, to improve the occlusion or fit, can do these adjustments in the form of grinding. Grinding can induce the internal flaws of a depth of 30–40 µm in feldspathic porcelain and causes 80 % reduction in strength (11). But in contrary newer glass ceramics and zirconia-based ceramic, grinding can increase the strength of ceramics (12). In reality, removal of the glazed surface of ceramics can cause the unfavorable secondary impact on opposing teeth. Glazing or reglazing is the most accepted method of sealing surface roughness. But recent studies have suggested that a polished surface can also seal the rough surface of ceramic and control the surface luster (21). A review of ceramic polishing concludes that an adjusted surface can be reglazed or sequential finishing and polishing using Shofu porcelain veneer kit should be used (8). Four stages of finishing:

- Hybrid points with fine grade 15 µm;
- Dura-white stones;
- Ceramiste silicone rubber points;

- Ceramiste silicone rubber cups with fine diamond polishing paste Westone Diglaze).

Conclusion

With the expansion of new all ceramic system production technology ceramists and clinicians have more options to choose from for different clinical situations, in addition to traditional ones. Modern production techniques ensure high quality and satisfies all predicaments. Results of long term studies of all ceramic crowns strongly recommends its use in the anterior and posterior area, but long term study results of new all-ceramic bridges are limited.

- Combination of high strength oxide based ceramic with aesthetic feldspathic veneering ceramic can satisfy a broad spectrum of versatile shades of teeth.
- Along with conventional cementation techniques, sensitive multi-step resin cementation is strongly recommended.
- Polishing of all-ceramic using sequential finishing using Shofu porcelain veneer kit in 4 stages.
- Continuous updating of scientific knowledge is most significant for appropriate material selection and its success.

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