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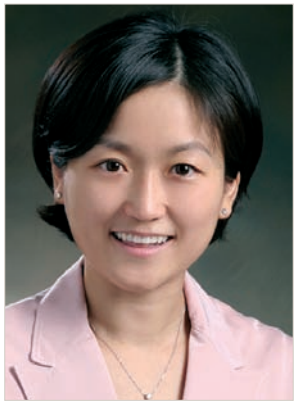
Dear Reader,



Dr So Ran Kwon
Co-Editor-in-Chief

_Colour measurement of human teeth and restorative materials has become an integral component of both clinical practice and dental research. This importance is reflected in the immense growth of the Society for Color and Appearance in Dentistry (SCAD), founded in 2008 as a consortium of dental professionals and other experts interested in the area of aesthetic dentistry specially related to scientific investigation and the relationship between colour and appearance.

Colour matching has always been a challenge, especially in the anterior region, regardless of the restorative materials used. Although many regard ceramics as the restorative material of choice for ensuring increased longevity and superior aesthetics, composite materials have been gaining favour because of their minimally invasive nature, excellent aesthetic potential, and relatively low cost. Restoration using composite has evolved dramatically with the development of new resin composite materials with excellent optical properties emulating dentine and enamel. Proper application of the natural layering technique, which seeks to imitate the optical and anatomical characteristics of natural teeth, using these new composite materials can provide solutions to overcome the aesthetic challenges faced in so many clinical situations.

With the increased development and evolution of digitally created restorations, the rationale for material selection in ceramic restorations has changed significantly. However, even with the introduction of high-technology devices, there is still a need for proper interpretation of shade information in creating the ceramic build-up and the illusion of a natural tooth by ceramic layering techniques.

Special emphasis in colour matching has been placed on the critical pink interface. The underlying titanium implant may shine through delicate peri-implant mucosa, resulting in the greyish appearance of the gingival cuff. Optical evaluation of the gingival colour and a multidisciplinary approach to the interface planning will simplify treatment and provide predictable aesthetic outcomes.

In this issue of cosmetic **dentistry**, we have included beautifully illustrated and well-documented articles that report on restorations with resin composites and ceramics. I hope you will enjoy this edition and successfully apply your new knowledge to your daily practice.

Yours faithfully,

So Ran Kwon

Dr So Ran Kwon
Co-Editor-in-Chief
President, Korean Bleaching Society
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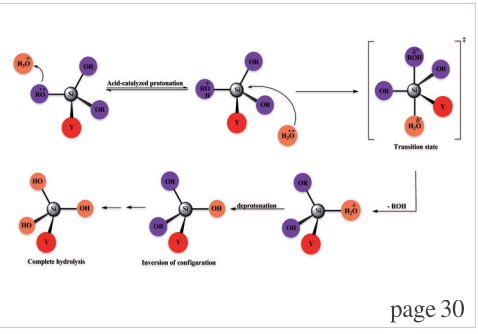
Cover image courtesy of Rido



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Ceramics: Rationale for material selection

Authors_Prof. Edward A. McLaren & Yair Y. Whiteman, USA


Fig. 1


Fig. 2


Fig. 3

Fig. 1_Image of prepared tooth: Significant dentine is exposed along the proposed length, flexure and tensile stress risk is at least medium, and the restoration thickness would be at least 0.9 mm. This was noted in the chart.
Fig. 2_Image demonstrating excessive enamel crazing, leakage, and staining. Flexure, tensile, and shear sheer risk would be medium to high. The substrate would depend on preparation.
Fig. 3_Image demonstrating deep overbite in which shear and tensile stresses would be at least medium. Bonded porcelain would require maintenance of enamel and an occlusal strategy to reduce leverage on the teeth.

_Abstract

All imaginable types of materials and techniques, from very conservative ceramic restorations to very complex restorations of either metal or high-strength crystalline ceramics veneered with porcelain, have been introduced and tried over the years, with varying levels of success. Unfortunately, there is considerable misinformation, and a general lack of published rational treatment planning guidelines, about when to use the ceramics available in dentistry. This article provides readers with a systematic process for treatment planning with ceramic materials. Specific guidelines are outlined for the appropriate clinical conditions for using the various ceramic materials available.

_Introduction

Many types of ceramic materials and processing techniques have been introduced throughout the years. As early as 1903, Charles Land patented all-ceramic restorations, using fired porcelains for inlays, onlays and crowns.[1] Insufficient understanding of material requirements for survival in the oral environment, poor ceramic processing techniques, and the inability of adhesive cementation led to early catastrophic failure. Since then, all imaginable varieties of materials and techniques, from very conservative ceramic restorations to very complex porcelain veneered of either metal or high-strength crystalline ceramics, have been introduced and tried with varying levels of success.[2] The authors have previously published two detailed descriptions of, or classification systems for, ceramics used in dentistry, one based on the microstructure of the material and the second on the way in which the material is processed.[3]

There is considerable misinformation and a general lack of rational treatment planning guidelines published regarding the use of different ceramics in dentistry. The literature is replete with various accounts of clinical success and failures of all types of dental treatments. Sadowsky[4] published a review of the literature covering treatment considerations using aesthetic materials, for example whether to use amalgam or composite and the success rates of different treatments. No recent literature could be found presenting a thorough discussion of when to use the various ceramics, for example when feldspathic porcelains should be used, when either pressed or machined glass-ceramics are appropriate, when different types of glass-ceramics should be employed, when a high-strength all-ceramic crown system of either alumina or zirconia is ideal, and when metal ceramics are suitable.

This article provides a systematic stepwise process for treatment planning with ceramic materials and presents specific guidelines for the appropriate clinical conditions for applications of the various systems.

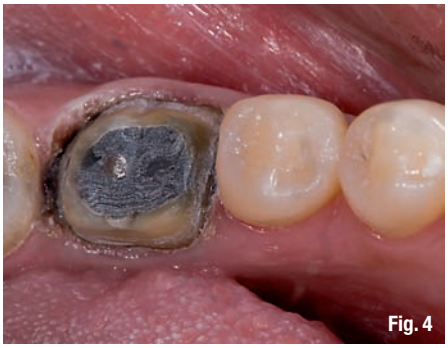
Fig. 4


Fig. 5


Fig. 6

Fig. 4_Image of preparation with poor substrate and subgingival margins where maintaining seal would be difficult. High-strength ceramics or metal ceramics would be indicated.
Fig. 5_Image of minimal preparations prior to receiving bonded porcelain.
Fig. 6_Two-year post-op image of very conservative Category 1 bonded porcelain restorations, using VITA VM porcelains.

_Treatment philosophy

A treatment philosophy based on current standards of care that consider the patient's aesthetic requirements is a prerequisite to making any decision regarding the use of a material or technique. More importantly, this philosophy should be aimed at maintaining the long-term biological and structural health of the patient in the least destructive way.

Restorative or aesthetic dentistry should be practised as conservatively as possible. The use of adhesive technologies makes it possible to preserve as much tooth structure as feasible while satisfying the patient's restorative needs and aesthetic desires.[5] The philosophy today is not to remove any healthy tooth structure unless absolutely necessary. This will reduce dentists' frustration when orthodontics would have been the ideal treatment. With restorations, clinicians should choose a material and technique that allows the most conservative treatment in order to satisfy the patient's aesthetic, structural, and biological requirements, and that meets the mechanical requirements to provide clinical durability. Each of these requirements could be the topics of individual articles.

There are four broad categories or types of ceramic systems:

1. powder/liquid feldspathic porcelains;
2. pressed or machined glass-ceramics;
3. high-strength crystalline ceramics; and
4. metal ceramics.

Category 1

Porcelains—the most translucent—can be used the most conservatively, but are the weakest.[3,6]

Category 2

Glass-ceramics can be very translucent too but require slightly thicker dimensions for workability and aesthetics than porcelains do.

Categories 3 and 4

High-strength crystalline ceramics and metal ceramics, although demonstrating progressively higher fracture resistance, are more opaque and, therefore, require additional tooth reduction and are thus a less conservative alternative.

Based on the treatment goal of being as conservative as possible, the first choice will always be porcelains, then glass-ceramics, followed by high-strength ceramics or metal ceramics. The decision will be based on satisfying all the treatment requirements, that is, if the more-conservative material meets all the treatment requirements then that is the ideal choice. The article will identify the clinical conditions in which treatment requirements dictate the use of a specific category of ceramics.

_Space required for aesthetics

The first consideration is the final 3-D position of the teeth, that is, smile design. There are several resources available for smile design.[7,8] The second consideration is the colour change desired from the substrate (tooth), since this will dictate the restoration thickness. In general with porcelains, a porcelain thickness of 0.2–0.3 mm is required for each shade change (A2 to A1 or 2M1 to 1M1). For example, A3 to A0 would require a veneer of 0.6–0.9 mm in thickness.

Glass-ceramics have the same space requirements as porcelain for effective shade change; however, the authors find it difficult to work with this category and produce the best aesthetic results when the material is less than 0.8 mm in thickness. High-strength all-ceramic crowns require a thickness of 1.2–1.5 mm, depending on the substrate colour, and metal ceramics need a thickness of at least 1.5 mm to create lifelike aesthetics. With that in mind, a diagnosis based on tooth position and colour change will direct treatment planning, as well as the final decision regarding tooth preparation design (i.e. total tooth structure reduction)


Fig. 7


Fig. 8

Fig. 7_Pre-op image of a case for an inlay in tooth 18 and onlay in tooth 19.
Fig. 8_Post-op image using non-layer IPS e.max HT.

and whether orthodontic treatment is required to facilitate a more conservative and aesthetic outcome.

_Clinical parameters to evaluate

Once the 3-D smile design has been completed, colour change assessed, and adjunctive therapy finished to create an environment that will allow the least removal of healthy tooth structure, an evaluation of each tooth is needed for ascertaining which ceramic system and technique are most suitable. The evaluation of individual teeth for specific material selection involves assessing four environmental conditions in which the restoration will function.

Substrate

The first consideration is evaluating the substrate to which the material will be attached (Fig. 1). Is it enamel? How much of the bonded surface will be enamel? How much enamel is on the tooth? Is it dentine? How much of the bonded surface will be dentine? What type of dentine will the restoration be bonded to (tertiary or sclerotic dentine exhibits a very poor bond strength, and bonding to this type of dentine should be avoided when possible)? Is it a restorative material (e.g. composite, alloy)? These questions should be addressed for each tooth to be restored, since this will be a major parameter for material selection.

It is generally understood and accepted that a predictable and high bond strength is achieved when restorations are bonded to enamel, given the fact that the stiffness of enamel supports and resists the stresses placed on the materials in function. However, it is equally understood that bonding to dentine surfaces, as well as composite substrates, is less predictable given the flexibility of these substrates. The more stress placed on the bonds between dentine and composite substrates and the restoration, the more damage to the restoration and underlying tooth structure is likely to occur. Therefore, because enamel is significantly stiffer than either dentine or composite and much more predictable for bonding, it is the ideal substrate for bonded porcelain restorations.

Flexure risk assessment

Next is the flexure risk assessment. Each tooth and existing restorations are evaluated for signs of past overt tooth flexure. Signs of excessive tooth flexure can be excessive enamel crazing (Fig. 2), tooth and restoration wear, tooth and restoration fracture, micro-leakage at restoration margins, recession, and abfraction lesions. Often, the aetiology is multifactorial and controversial. However, if several of these conditions exist, there is an increased risk of flexure on the restorations that are placed, which may overload weaker materials. Evaluation of this possibility is also based on the amount of remaining tooth structure. The more intact the enamel is, the less potential there is for flexure.

The amount of tooth preparation can directly affect tooth flexure and stress concentration. There is much potential subjectivity in any observational assessment of clinical conditions; however, an assessment of flexure potential for each tooth to be restored is needed. A subjective assignment of low, medium, or high risk for flexure is based on the evaluated parameters, as outlined below:

Low risk for clinical situations in which there is low wear; minimal to no fractures or lesions in the mouth; and the patient's oral condition is reasonably healthy.

Medium risk when signs of occlusal trauma are present; mild to moderate gingival recession exists, along with inflammation; bonding mostly to enamel is still possible; and there are no excessive fractures.

High risk when there is evidence of occlusal trauma from parafunction; more than 50 % of dentine exposure exists; there is significant loss of enamel due to wear of 50 % or more; and porcelain must be built up by more than 2 mm.


Fig. 9


Fig. 10

Fig. 9_Pre-op image of case requiring significant lengthening. There is at least a medium risk of flexure and unfavourable stress, and some of the substrate would be dentine. Thus, Category 1 materials were eliminated as a choice.
Fig. 10_Post-op image of the same case using Category 2 materials, in this case VITABLOCS Mark II with minimal porcelain layering in the incisal one-third.

Excessive shear and tensile stress risk assessment

The third parameter is the risk (or amount) of ongoing shear and tensile stresses that the restoration will undergo, since the prognosis is more guarded for specific materials. All types of ceramics (especially porcelains) are weak in tensile and shear stresses.[9] Ceramic materials perform best under compressive stress. If the stresses can be controlled, then weaker ceramics can be used, for example bonded porcelain to the tooth. The same parameters are evaluated, similar to flexure risk, for example deep overbites and potentially large areas where the ceramic would be cantilevered (Fig. 3).

If a high-stress field is anticipated, stronger and tougher ceramics are needed; if porcelain is used as the aesthetic material, the restoration design should be engineered with such support (usually a high-strength core system) that it will redirect shear and tensile stress patterns to compression. In order to achieve that, the substructure should reinforce the veneering porcelain by utilising the reinforced-porcelain system technique, which is generally accepted in the literature as a metal–ceramic concept.[10] The practitioner can assess and categorise low, medium, or high risk for tensile and shear stresses based on the parameters and symptoms mentioned above.

Bond/seal maintenance risk assessment

The fourth parameter is the risk of losing the bond or seal of the restoration to the tooth over time. Glass-matrix materials, which consist of the weaker powder/liquid porcelains, and the tougher pressed or machined glass-ceramics, require maintenance of the bond and seal for clinical durability.[11, 12] Owing to the nature of the glass-matrix materials and the absence of a core material, the veneering porcelains are much more susceptible to fracture under mechanical stresses and, therefore, a good bond in combination with a stiffer tooth substructure (e.g. enamel) is essential for reinforcing the restoration. If the bond and seal cannot be maintained, then high-strength ceramics or metal ceramics are the most suitable, since these materials can be placed using conventional cementation techniques.

Clinical situations in which the risk of bond failure is higher are

_moisture control problems;
_higher shear and tensile stresses on bonded interfaces;
_variable bonding interfaces (e.g. different types of dentine);
_material and technique selection of bonding agents (i.e. as dictated by such clinical situations as inability to achieve proper isolation for moisture control to enable use of adhesive technology); and
_the experience of the operator (Fig. 4).

An assignment of low, medium, or high risk for bond and seal failure is based on the evaluated parameters.

_Category 1: Powder/liquid porcelains

Guidelines

Bonded pure-porcelain restorations are ideal as the most-conservative choice but are the weakest material and require specific clinical parameters to be successful.[13] Many good materials and techniques are available for bonded porcelain (e.g. Creation, Jensen Dental; Ceramco 3, DENTSPLY; EX-3, Noritake). However, VITA VM 13 (VITA Zahnfabrik) is recommended by the authors when 3D-Master shades are taken, and Vintage Halo (SHOFU) when classic shades are taken.

When following clinical parameters and guidelines at the University of California, Los Angeles's Center for Esthetic Dentistry (UCLA Center for Esthetic Dentistry), these materials have been used with similar success rates compared with porcelain fused to metal (i.e. less than a 1 % fracture rate if all parameters are followed, unpublished data; Figs. 5 & 6).