The Retention of MAD/MAM and CAD/CAM Y-TZP Crowns with Three Different Preparation Tapers

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بسم الله الرحمن الرحيم

﴿قالوا سبحانك لا علم لنا

إلا ما علمتنا إنك أنت

العليم الحكيم﴾

صدق الله العظيم

سورة البقرة "آية ٣٢"

Dedication

This work is dedicated to

My Family, *for their great care and support.*

To my unbreakable union, *my sisters, brother and my true friends, for their encouragement and great cooperation.*

Acknowledgement

First and foremost thanks are due to Allah the beneficent and merciful.

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The traditional porcelain-fused–to-metal fixed partial denture (PFM) is the most popular treatment option for the majority of dentists because of the familiar fabrication techniques and the acceptable esthetic outcome. The frequent gingival discolorations around the metal margins of PFMs, together with some allergic reactions by metal alloys, are still a weak point of these restorations that dissatisfies both patients and dentists. The demand for full ceramic restoration is increased therefore pressure is exerted on industry and science to develop full ceramic system.

Researchers have been developed new high-strength ceramic materials that can be used for the fabrication of core material of fixed restoration. The most recent core material for all ceramic crown is the Yttrium Tetragonal Zirconia Polycrystals (Y-TZP) based material which has excellent mechanical properties, biocompatibility and low bacterial adhesion. The sintering behavior of this material does not allow the fabrication by direct sintering on customized dies, Therefore (Y-TZP) coping can only be fabricated by milling techniques. These milling techniques are either Manual Aided Design/Manual Aided Manufacturing (MAD/ MAM) or Computer Aided Design/Computer Aided Manufacturing (CAD/CAM).

The design of the tooth preparation is an important consideration in tooth reconstruction. The use of certain geometric features in preparations for full coverage restorations has been based largely on experience and individual preference. Early studies of designs of preparations were based on theoretical considerations of the way in which preparation features could be expected to geometrically resist tipping and removal forces. [١], [٢]

Taper of a complete crown preparation has been the overriding feature shown to aid retention. The aim of this study is to evaluate the effect of different degrees of preparation taper and milling techniques on the retention of Y-TZP copings.

Historical perspectives of ceramics

As early as at the end of the ١٩th century, all-ceramic restorations, called jacket crowns, were fabricated by firing a feldspathic ceramic material on a die prepared with platinum foil. Jacket crowns were the only fixed esthetic restorations available at that time. [٣] Despite their esthetic advantages, the restorations failed to gain widespread popularity because of their high probability of fracture, low strength and poor marginal seal. This technique went out of fashion once the metal-ceramic era began. [٤] A noteworthy development occurred in the ١٩٥٠s, with the addition of leucite to porcelain formulations that elevated the coefficient of thermal expansion to allow their fusion to certain gold alloys to form complete crowns. [٣]

In ١٩٦٧, McLean introduced the idea of fabricating a high-alumina ceramic for the fabrication of FPDs. [٥] As further innovation, in ١٩٨٢ McLean introduced the platinum-bonded alumina FPD to reduce the problem of fracture through the connector area while eliminating the traditional cast metal framework. [٦] However, this restorative option demonstrated a high rate of failure at the connector sites. Since then, developments in dental ceramics have led to the introduction of new high-strength ceramics. [٧]

Composition, properties and limitations of dental ceramics

Dental ceramics consist of a compound of metals (aluminum, calcium, lithium, magnesium, potassium, sodium, tin, titanium, and zirconium) and nonmetals (silicon, boron, fluorine, and oxygen) that may be used as a single structural component, such as when used for a CAD-CAM inlay, or as one of several layers used for the fabrication of a ceramic-based restoration. Conventional dental porcelain is a vitreous ceramic based on a silica ($SiO_{٢}$)

network and potash feldspar ($K_{٢}O·Al٢O_{٣}·٦SiO_{٢}$), soda feldspar ($Na_{٢}O·Al_{٢}O_{٣}·٦SiO_{٢}$) or both. Pigments, opacifier and glasses are added to control the fusion temperature, sintering temperature, thermal contraction coefficient, and solubility. The feldspars used for dental porcelains are relatively pure and colorless. Therefore, pigments must be added to produce the hues of natural teeth.

Most of the ceramics are characterized by their refractory nature, hardness, and chemical inertness. A hardness of a ceramic similar to that of enamel is desirable to minimize the wear of resulting ceramic restorations, and reduce the wear damage that can be produced on enamel by the ceramic restoration. Chemical inertness ensures that the surface of dental restorations does not release potentially harmful elements, and reduces the risk for surface roughening and an increased susceptibility to bacterial adhesion to insure excellent biocompatibility over time. Furthermore, ceramics demonstrate excellent insulating properties, such as low thermal conductivity, low thermal diffusivity, and low electrical conductivity. Their most attractive property is their potential for matching the appearance of natural teeth, offering great esthetic results. [٨] Inspite of their excellent esthetic qualities and biocompatibility, dental ceramics are brittle and contain both fabrication defects and surface cracks, from which fracture can initiate. Forces in the form of tension cause these cracks to open up, followed by crack propagation. (Crack propagation theory). [٩]