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RESEARCH ARTICLE

RESIN-MATRIX CERAMICS – AN OVERVIEW

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ABSTRACT

The introduction of CAD-CAM system and machinable ceramics enabled the dentist to provide restorations with good aesthetics and superior physical properties. Resin matrix ceramics is a new class of ceramics which combines the positive aspects of both ceramics and polymer matrices. The material comprises of an organic matrix with highly filled ceramic particles. It was introduced to overcome certain physical properties that where undesirable for conventional CAD-CAM ceramics. Resin matrix ceramics has modulus of elasticity comparable to dentin and can be easily milled and adjusted intraorally.

INTRODUCTION

With the increase in the concerns about biocompatibility and high aesthetic demands for dental restorations, dentists and patients had moved more towards metal-free tooth coloured restorations.[1] Although all-ceramic restorations are routinely used for dental restorations due to their catastrophic failure mode they always have to get replaced. To improve the mechanical and optical characteristics industrially made CAD-CAM ceramic blocks have been introduced.[2]

The target of restorative dentistry is to reinstate lost tooth structure with restorative material which mimics the properties of the natural tooth in its physical and structural properties.[2,3] Resin matrix ceramics where introduced to attain material which has elastic modulus comparable to dentin and which can be effortlessly milled and adjusted than conventional CAD-CAM ceramic materials. They are particularly devised for CAD-CAM. Resin matrix ceramic restorations may be used as an equivalent alternative to glass-rich-ceramic regarding mechanical performance.[4] Resin matrix ceramics is composed of a highly filled organic matrix in an inorganic refractory material consisting of porcelain, glasses, glasses and ceramics. Depending upon their inorganic contents they may be classified into several sub families.[4]

Resin matrix ceramics

1. Resin Nano ceramic
2. Glass ceramic in a resin interpenetrating matrix
3. Zirconia-silica ceramic in a resin interpenetrating matrix

Resin Nanoceramics (E.g: Lava Ultimate)

It consists of a Nano-ceramic particles of about 80% by weight in a highly cured organic resin matrix. The inorganic Nano ceramic part composed of discrete silica nanoparticles (200nm), zirconia nanoparticles (4-11nm) and zirconia – silica Nano clusters. The polymer to ceramic ratio is about 80:20% by weight.[5] Resin Nano ceramics has a modulus of elasticity comparable to dentin and is less brittle than glass ceramics. Since they are resilient, they are well resistant to chipping and cracking during milling. The material has the ability to maintain the high glossy surface finish for a longer period of time than the conventional CAD-CAM blocks.[6,7] Recent studies concluded that Resin Nano Ceramics tends to debond at the luting cement-crown interface especially used in cases of

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implant single crowns. Since resin matrix ceramics are resilient, elastic deformation occurs within the crown and this stress concentration may be transferred to the adhesive layer leading to debonding issues. The material is no longer considered an indication for crowns[8]. Indicated in inlays, on lays and veneers

Advantages Include

- Can be easily adjusted and re-polished
- Good wear resistance
- Resistant to extrinsic stains
- Lesser wear to antagonist's tooth when compared to glass ceramics
- No post firing required so fewer lab procedures
- High flexural strength(200mPa)

Glass Ceramic In A Resin Interpenetrating Matrix (Eg: Vita Enamic)

The manufacturer describes it as hybrid ceramic. Hybrid ceramics consists of a paired polymer network of urethane dimethacrylate {UDMA} and triethylene glycol dimethacrylate {TEGDMA}. The Feld spathic ceramic network is composed of

- SiO2(58–63%) by weight
- Al2O3 (20–23%)
- Na2O(6–11%)
- K02O(4–6%)
- B2O3(0.5–2%)
- CaO (<1%)
- TiO2(<1%)

It is made by initially sintering the powder porcelain to about 70% of its density and later infiltrating with monomers. It has flexural strength of 160MPa and elastic modulus of 38GPa.[9] The polymer to ceramic ratio is about 86:14% by weight. The material managed to combine the positive properties of both the ceramic and composite to provide a balance between strength and elasticity, thus takes up the masticatory forces. Indicated incrowns, inlays/onlays, veneers Contraindicated in bridges, para-functional habits

Indicated in crowns, inlays/on lays, veneers

Contraindicated in bridges, para-functional habits

Advantages

- Lower brittleness
- Can be milled into thin sections without fracture/crack propagation
- High modulus of elasticity compared to traditional ceramics
- Restorations can be altered with diamond instruments
- Less milling time required

Zirconia-Silica Ceramic In A Resin Interpenetrating Matrix (Paradigm M Z100)

It was introduced in 2000.[5] They are composed of 85% inorganic contents and 15% different organic matrices. The inorganic content comprises of ultrafine zirconia-silica ceramic particles encapsulated in a polymer matrix of Bisphenol A Glycidyl methacrylate (BIS-GMA), TEGDMA and a patented ternary initiator system. PARADIGM MZ100 is a factory processed version of Z100 restorative resin[5,6]. Paradigm MZ100 crown restorations found to have clinically acceptable marginal adaptability.[10] Material wear found to be twice compared to feldspathic and leucite reinforced ceramics.[7] Unlike other porcelain restorations, Paradigm restorations found to retain their baseline colour in clinical studies.[5,6,11]

Advantages

More conservative tooth preparation is acceptable.

- Easier finishing and polishing.
- Can be easily adjusted intraorally.
- Easier colour characterization.
- Lesser wear to opposing teeth.
- Flexural strength – 150MPa

Indication includes inlays/onlays, crowns, veneers

DISCUSSION

Resin matrix ceramics composed of an organic polymeric matrix reinforced by inorganic filler particles.[4] The ratio between the polymer content and porous ceramic particles impact the mechanical properties including flexural strength, elastic modulus hardness, strain at failure.[9,12] Manufacturers add up specific filler mainly to improve the optical properties. The dimensional changes of the resin depend on the monomers used like BISGMA, UDMA, UTMA and BISEMA.[13]

Mechanical properties of resin matrix are found to be similar to natural dentin and enamel.[14] This new generation class of ceramics is found to be ideal for non-invasive restorations of about 0.5mm.[8] The new-generation polymer-based ceramics exhibited significantly higher flexural strength and modulus of resilience, along with lower flexural modulus values compared with regular ceramic materials.[15] Crowns milled from the resin-based blocks seemed to exhibit visibly smoother margins.[16] Resin matrix ceramics has comparatively lower hardness values, so they cause very less wear to the antagonist teeth. The material found to have similar indentation creep as that of enamel, but it does not have the ability to recover once the load has been removed.[17,18] The probable reason could be due to the fracture of ceramic particles that get interlocked and prevents the elastic recovery of the polymer. Regular ceramics do not exhibit creep, resin matrix ceramics have better stress redistribution.[18] The failure rates in resin matrix ceramics varies among materials and the cause of degradation is due to the difference in composition and microstructures.[19] Post cure treatments have found to improve the resin quality and mechanical fatigue resistance.[19,20,21] A well-polymerized resin matrix enhance the material resistance to crack propagation.[10,22]

CONCLUSION

Resin matrix ceramics can be used as an alternative to glass ceramics for prosthodontics management in areas of low chewing loads with clinically acceptable performance. Though resin matrix ceramics found to be more aesthetic, has comparable mechanical properties to regular CAD-CAM ceramics, long term studies are needed to understand the clinical behaviour and failure rates.

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