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Zirconia in Dentistry

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Abstract:
Zirconia is a crystalline form of zirconium dioxide optically flawless, usually colourless. The main use of Zirconia is the production of ceramics. An Ideal all ceramic restorations that can forms well a demonstrates enhanced bio compatibility, strength, fit an aesthetics has always been desirable in clinical dentistry. The popularity of all ceramic dental restorations has invented in the recent years because of liens aesthetics appearance & metal free structure.
It has a good mechanical and chemical properties with CAD/Computer aided manufactory systems. Zirconia frameworks can be viable for the fabrication of full and partial coverage crowns fixed partial dentures, full verneers, posts & cores, primary double crowns, implant abutments& implants.
This systemic review of zirconia aims to presents the uses of zirconia in dentistry & manufacturing methods in clinical application.

1. Introduction

Yttrium tetragonal zirconia polycrystal (Y-TCP) has been extensively described in the literature & currently applied in different fields of dentistry. Addition to high strength all ceramic system used for crowns & fixed partial dentures.[1]

An introduction of zirconia based core ceramics produces more predictable treatment options. zirconia has numerous characteristics that makes it attractive for use in dental restorations, including the proposal denture appliance. Although titanium is used in dental implantology, there is a trend to develop new ceramic based implants as an alternative to monolithic titanium. The material of choice for manufacturing dental implants has been for long commercially pure titanium because of its excellent biocompatibility and mechanical properties[2]. However the gray colour of titanium can give rise to esthetic problems.

The purpose of this review article is to address current knowledge regarding advantage/dis advantage and uses of zirconia ceramic material in dentistry.

2. Properties of Zirconia

The flexural strength of zirconia oxide materials has been reported to be in the range of 900 to 1,100 MPa.l This is approximately twice as strong as alumina oxide ceramics currently on the market and 5 times greater than standard glass ceramics. Even more important is the fracture toughness of the material. Fracture tough-ness measures the ability of a material to resist propagation of an internal crack (fracture). This is an important indication of a material's clinical re liability. Clinically, nonfatal cracks (cracks that develop in the zirconia but do not result in complete fracture or failure of the restoration) form from cyclic fatigue, which can lead to failure of the restoration if the cracks propagate. A Zirconia's fracture toughness is between 8 and 10 MPa mll2,4 which is almost twice as high all that of aluminum oxide ceramics. This is due to transformational toughening, which gives zirconia its unique mechanical proper-ties. Because of its tetragonal polycrystalline structure, when a crack develops the material transforms to a thermodynamically more favorable monoclinic form. This transformation is associate d with a 4% local increase in volume, which produces a "clamping effect" on the crack and halts its further expansion. In addition, without any glass matrix, zirconia oxide materials are generally strong er and offer more res instance to cracking than other ceramice. Further, chemical corrosion occurs on glass substrates, which can lead to clinical failure. The aqueous component in saliva can react with glass in ceramic materi-al, causing corrosion. This can increase the rate of crack propagation and lead to failure of the material.

3. Zirconia in Single Tooth (Crowns)

Crowns are given in cases, which is requires a change in the occlusal plane along with the requirement. The tooth preparation of zirconia crowns differs from other metal ceramic crowns. Correct appropriate tooth preparation of zirconia crown should provide functional stress. Generally tooth preparation of zirconia restoration requires 1.55mm to 2.00mm incisal or occlusal reduction. Axial coverage of the crown should be 6^0 degree tapered.(3)

Subgingival chamfer or marginal shoulder should be given. Preparation should be smooth and uniform. In case a axial convergence angle form 6 to 20^0 degree may decrease the prepared abutment and the zirconia core.For single posterior crowns minimum 0.5thickness of zirconia should be fabricated. Especially in the anterior region strength and esthetic requirement allows the fabrication of 0.3mm thick coping. zirconia crowns all cemented using resin modified glass ionomers & composite resin cements.(4)

4. Zirconia in fixed partial denture.

The patients with missing teeth can undergo 3 types & treatment. Fixed partial dentures (FPD), removable partial denture (RPD) & implant. Among all three, FPD has sufficient aesthetic & functional outcomes. Usually FPDs are further divided according into retainers, resin bonded fixed partial denture made of metal. Zirconia is the recent material used for fabrication of all ceramic FPDs either anterior or posterior. It has high fracture resistance after veneering.After the fabrication Y-TCP is opaque & white. Hence is has good aesthetics. It has a traditional FPDs has a high success rate but requires a substantial amount of tooth reduction to achieve the best esthetics.(5) Long-term preservation of the pulp is always uncertain. Light transmission may also be reduced despite the use of a porcelain butt joint. All-ceramic FPDs require a substantial amount of tooth structure removal. If the adjacent abutments have no restorations, an implant or resin-bonded FPD may be a better alternative.

It has been demonstrated that FPDs created as single-retainer restorations have better survival rates than traditional two-retainer resin-bonded FPDs. The single-retainer resin-bonded FPD may allow less tensile stress at the connector and adhesive interface.2-4 Recent advances in adhesive technology and ceramic materials allow all-ceramic, single-retainer resin-bonded FPDs to be used in addition to metal retainers. Ceramics possess desirable characteristics: chemical stability, biocompatibility, high compressive strength, and a coefficient of thermal expansion similar to tooth structure.5 Clinicians can choose from a wide range of ceramic products, and zirconia has been used in dentistry for a broad array of indications. Zirconia has favorable esthetic, mechanical, and biomechanical properties.Densely sintered zirconia possesses the highest flexural strength of approximately 1,000 MPa. Zirconia can be used for conventional FPDs or resin-bonded FPDs due to its superior mechanical properties and high fracture toughness. Hydrofluoric acid is used as a predictable basis for roughening the surface of feldspathic ceramic for bonding composite resin. High alumina content or zirconia content cannot be treated in this manner because they do not contain the silicon dioxide (silica) phase.[6] Air abrasion with silica-containing particles (silica coating), followed by silanation, has been used on zirconia ceramics with various results. Silica coating has produced durable resin bonding for some zirconia ceramics.[7]

Several bonding agents have previously been investigated, and only those containing an organophosphate ester monomer have been proven to be effective. According to recent studies, the combination of airborne-particle abrasion and a 10-methacryloyloxydecyl dihydrogen phosphate (MDP) monomer is the recommended method for bonding resin composites to zirconia.[8]

5. Zirconia Posts

A post & core is a type & dental restoration that utilities when there is a inadequate tooth structure remaining to support the restoration.A metal post & core system restricts light transmitting & thus gives an undesirable dark shadow in the tooth & central areas, especially through periodontal tissues. Denture like shade all ceramic posts & cores contribute to adequate diffusion of light, appropriate depth & translucency.[9]

A small rod, usually metal, is inserted into the root space of the tooth & protrudes from the root a couple of millimetres. The rod referred as post. The post used to hold the filling is called the core.The tooth color leaves less of a shadow under the final restoration.[10]

All ceramic cores of 2 types direct & indirect, a ceramic cores formerly fabricates with the use of copy milling or CAD/CAM technology. The Clinical application of Zirconia post is an almost irreversible procedure & rarely it is extremely diffcult.

6. Zirconia Implants & Abutments

A dental implant is a root device usually made of titanium, used in dentistry helps in restoration that actually resemble a tooth to replace a missing teeth.Forty years ago oral implants appeared on the market for clinical uses. Zirconia was introduced into dentistry in the 1990s and currently being used as the material for posts for tooth build up, crown bridge work, implant and abutments.[11]

Zirconia currently considered as an attractive & advantageous dental implant material because it present enhanced biocompatibility,improved mechanical properties, radiology soft tissue tolerance for zirconia is high. Now there are 5 types of zirconia used in dentistry for various uses.The first ceramic abutment ceramic core was introduces in 1993 in small. It was a type and alumina ceramic, compared to metal ceramic these new abutments of zirconia has a high bio compatibility & low thermal conductivity. For the preparation of the dental abutment a impression taken at the implant level. Zirconia ceramic (900-1400 mpa) has twice the flexural strength that of alumina ceramic.[12] Y-TZP abutments are available in two types, prefabricated and custom made. Prefabricated one beneficial in CAD/CAM technology in designing fully individualized zirconia abutments for ideal soft tissue integration and esthetics.

7. Other Auxiliary Components

Such as

- Orthodontic brackets
- Precision attachments
- Cutting & surgical instrument

8. Discussion

The upcoming technology has many origins of zirconia and which is clinically useful for practice & dentistry.Currently the Y-TZP & Zirconia is widely used in dentistry because it is exactly bio compatibility in the soft tissue & high fracture resistance. It is used in FPP, TMP as well as implant abutments. Current in vitro research, performed tounderstand the nature of the technology, included cell, thermal fatigue, colorimetric, marginal fit, fracture strength, and bonding studies. In vitro results are promising, especially in all aforementioned fields, how- ever, since clinical research focuses on how technology affects humans and other living organisms, extensive clinical application of the zirconia technology should await confirmation through cohort longitudinal clinical studies. Despite the known high biocompatibility of zirconia in both soft and hard tissues, dental zirconia restorations are slowly moved from the controlled experimental setting to the clinical environment and some clinical studies of up to five years can be found in the literature. Existing studies evaluated clinical parameters (eg, fit, color performance, survival rates) and determined the frequency of adverse effects (eg, chipping, fractures, debonding), mainly regarding the clinical application of zirconia FPDs and posts. At the conclusion of the present review, it is essential to underscore that zirconia technology is the most recent of the amazing advances in the CAD/CAM industry. Supporting technologies regarding digitalization, computer, and lasers will continue to revolutionize dentistry so that "virtual labs" might even replace traditional dental technology. Current clinical findings may provide a glimpse of research orientation and highlight future trends. Zirconia al- ready has a past and an ambitious present however, for the fulfilment of the "dream," all observed or future complications must be overcome through basic re- search and long-term clinical evaluation.[13]

9. Conclusion

- Excellent physical & mechanical properties, bio compatibility & superior esthetics makes zirconia a popular material among the all contemporary all ceramic material.
- It also satisfies marginal fit.
- The studies shows promising survival regarding tooth supported restoration but also reveals significant complication such as early fractures verneers or core material.
- A basic research of Zirconia should be conducted in the field of aging,veneering, bonding, frame work design, eastletics & clinical outcomes.

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