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ZIRCONIA DENTAL IMPLANTS: REVIEW

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ABSTRACT

Background:

Zirconia has emerged as a versatile dental material due to its excellent aesthetic outcomes such as color and opacity, unique mechanical properties that can mimic the appearance of natural teeth and decrease peri-implant inflammatory reactions.

Objective:

The aim of this review was to critically explore the state of art of zirconia surface treatment to enhance the biological and osseointegration behaviour of zirconia in implant dentistry.

Materials and methods:

An electronic search in PubMed database was carried out using the following combination of key words without time periods: "zirconia implants" "zirconia surface treatment" or "zirconia surface modification" or "zirconia coating" and "osseointegration"

INTRODUCTION:

The rehabilitation of completely and partially edentulous patients with dental implants is a scientifically accepted and well documented treatment modality.[1]Currently, titanium and titanium alloys are the materials most often used in implant manufacturing and have become a gold standard for tooth replacement in dental implantology. These materials have attained mainstream use because of their excellent biocompatibility, favourable mechanical properties, and well documented beneficial results.[2,3] When exposed to air, titanium immediately develops a stable oxide layer, which forms the basis of its biocompatibility. The properties of the oxide layer are of great importance for the biological outcome of the osseointegration of titanium implants. [4]The principal disadvantage of titanium is its dark greyish color, which often is visible through the peri-implant mucosa, therefore impairing esthetic outcomes in the presence of a thin mucosal biotype.

Because of these disadvantages, novel implant technologies that produce ceramic implants are being developed.[5]However, ceramics are known to be sensitive to shear and tensile loading, and surface flaws may lead to early failure. These realities imply a high risk for fracture.[6] In recent years, high strength zirconia ceramics have become attractive as new materials for dental implants. They are considered to be inert in the body and exhibit minimal ion release compared with metallic implants. Yttrium-stabilized tetragonal zirconia polycrystals appear to offer advantages over aluminium oxide for dental implants because of their higher fracture resilience and higher flexural strength.[7]

ZIRCONIA IMPLANT:

Dental implantology has seen the introduction of zirconia implants as a titanium implant substitute. Based on its mechanical properties, biocompatibility, tooth-like color, and low propensity for plaque, zirconia seems like an excellent material for implants. The adsorption of blood proteins, platelets, and osteogenic cell migration point to a biological interaction between zirconia-based surfaces, despite the fact that zirconia has been argued to be an inert biomaterial. Dental implants made of titanium are currently the preferred material even though zirconia implants have aesthetic advantages over titanium due to the latter's lower mechanical strength[8]

Important factors for zirconia implants are:

1.Osseointegration

2.Zirconia surface modification

3.RTQ *(removal torque testing)*

4.stress analysis

5.Strength

1. **OSSEOINTEGRATION**:

As a dental material, zirconia has drawn a lot of interest. The addition of yttrium tetragonal polycrystals to zirconia increases its mechanical stability. Zirconia implants are being utilized more frequently as fixtures to replace lost teeth in implant dentistry because of their increased mechanical stability..[9]

Osseointegration is a biologically dynamic process in implant dentistry that results in direct bone contact. it varies according on the implant, surgery site, kind of bone, and health of the patient. Histomorphometric analyses can be used to assess the bone to implant contact (BIC) at various stages during the osseointegration process.[1] Zirconia has an ivory hue, which gives it an advantage over titanium. Research on the impact of zirconia surface modification on osseointegration in experimental animals have demonstrated bone apposition on zirconia implants with a range of surface treatments, such as sandblasting, etching, sintering, and coating.[10]Subtle variations in the zirconia surface have been found in certain studies to have a significant effect on bone apposition onto the implant surface. In a recent study, it was shown that sandblasting alone did not result in as much bone-to-implant contact as acid-etching, but alkaline-etching of zirconia implants did. When compared to sandblasting alone, alkaline etching produced lower bone-to-implant contact values. Remarkably, the presence of multinucleated giant cells on the implant surface was enhanced by both acid and alkaline etching techniques. 11

By adding alumina, zirconia stabilized with yttria can be made tougher. The performance of zirconia implants toughened with alumina was compared to zirconia and titanium implants in a study conducted on miniature pigs. [12] The commercially pure grade 4 titanium implants underwent alumina sandblasting and hydrogen chloride/sulfuric acid acid etching, while the two ceramic implants underwent alumina treatment first, then hypophosporous acid treatment. Osteointegration was attained by all implant types[13]

For patients who are partially or completely edentulous, the placement of dental implants has become standard practice. The pattern and sequence of intra-membranous osteogenesis, which begins with the formation of woven bone and progresses to the formation of parallel-fibered bone and lamellar bone, is followed by the healing of bone surrounding implants. The bone–implant interface is also a part of bone remodelling. Many animal studies as well as a few human ones have demonstrated that modern implants consisting of commercially pure grade 4 titanium, TiZr, and zirconia with a micro-rough surface are rapidly osseointegrated and biologically well tolerated. Implants made of surface-modified Ti6Al4V might act differently. An essential component of the typical osseointegration process seems to be multinucleated giant cells. Nonetheless, these cells are more prevalent on some dental implant materials.[14]Osteointegration is safe and long-lasting; high success and survival rates for specific implant systems support this. Investigations into implant loss unrelated to classical peri-implantitis are necessary. Patient variables that affect the immune system, bone cells, and bone turnover include (poly)medication. These factors may act alone or in conjunction with other factors to cause bone loss around osseointegrated implants.[15]

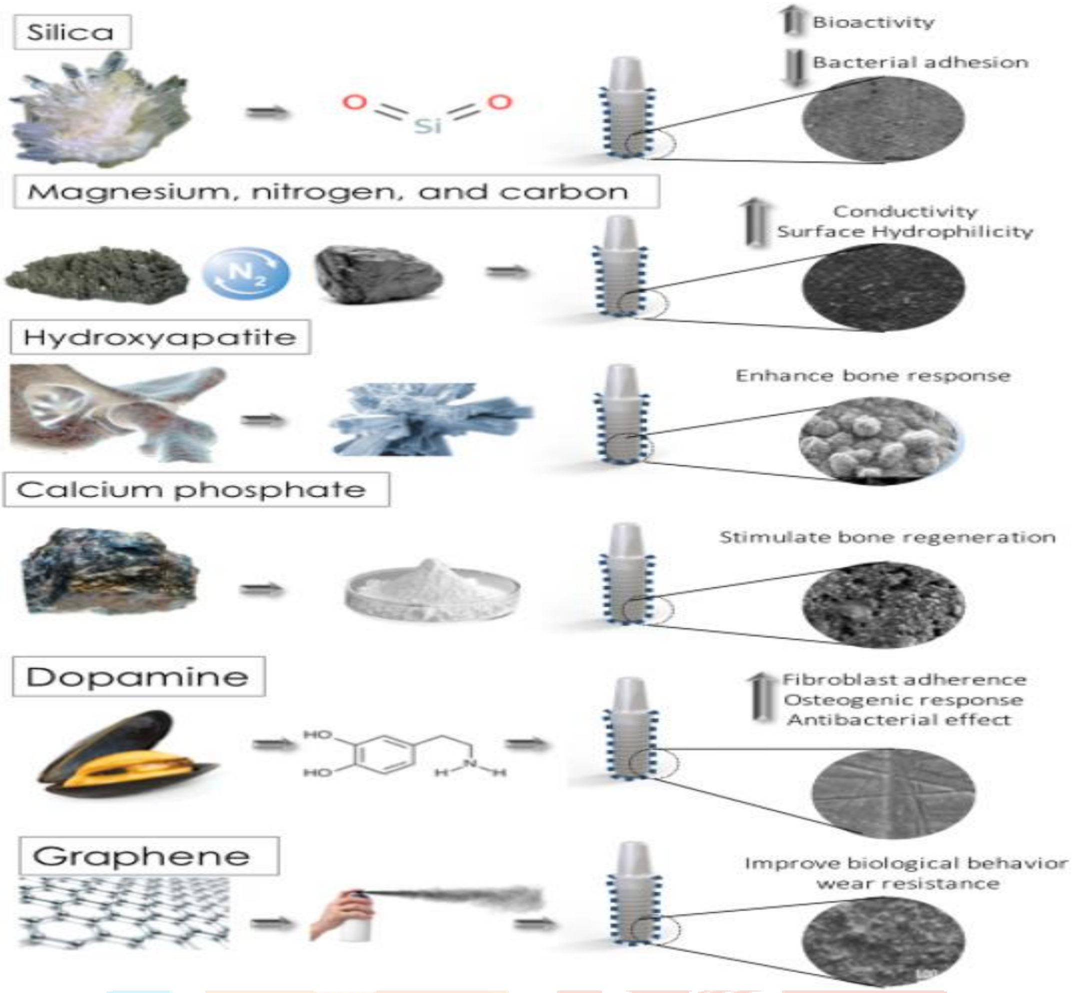
2.ZIRCONIA SURFACE MODIFICATION:

The surface modification of zirconia affects the fibroblast and osteoblast adhesion, proliferation, morphology, and differentiation that results in the osseointegration of implant surfaces. Predicting the clinical result and peri-implant tissue stability over time has been done by analyzing the impact of surface physicochemical modifications on biocompatibility and osseointegration as determined by histomorphometric analyses.[8]

. pic ref[8]

<u>Surface modification can be done by:</u>

1. Machined zirconia implant
2. Grit blasted and acid etched zirconia surface treatment
3. Ultraviolet light treated zirconia
4. Zirconia laser modification
5. Coatings on zirconia
6. Magnesium, nitrogen, and carbon coatings
7. Hydroxyapatite and calcium phosphate based coatings
8. Dopamine
9. Graphene coating



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ADVANTAGES OF ZIRCONIA IMPLANT:

- More aesthetic
- No chance of metal allergy
- May have lower risk of gum inflammation

DISADVANTAGES OF ZIRCONIA IMPLANT

- Less durable than titanium, as zirconia is more brittle and has a lower fracture strength.
- Over time, the material can deteriorate and lead to tiny cracks.
- The material is typically only available in one-piece implants.
- If a patient will need any adjustment following the fitting of the implant, they should avoid zirconia, as any grinding on the surface of the implant can weaken its fracture resistance.

Conclusion: Zirconia dental implants may have an osseointegration capacity similar to titanium implants based on available peer-reviewed data. They were also discovered to have stress levels that were low and evenly distributed, just like titanium implants. Furthermore, the initial bone healing and resistance to torque removal of titanium implants may be enhanced by the application of zirconia particles on their surface. It is said that zirconia has a surface roughness similar to titanium implants. Despite the difficulty of altering zirconia's surface, CO2 laser research has identified clear surface alterations, and more research on this method could lead to improvements in surface roughness. Zirconia implants that are coated or surface-modified exhibit higher values of withdrawal torque in comparison to those that are machined. It is advantageous to satisfy biomechanical requirements.

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