Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Spl Issue [2] 2022 : 544-549

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
REVIEW ARTICLE **OPEN ACCESS**

Surface Treatment in Dental Implants

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ABSTRACT
The success or failure of an implant depends on a variety of factors, including local, biological, clinician-influenced, and implant-specific factors. The Osseointegration of implants is greatly influenced by the physical quality and implant design. To find out the optimum technique to enhance an implant's surface condition, research is ongoing. This article examines the research on several recent advancements in implant surface treatments. Furthermore, it appeared that no significant biofilms could form on the polished anodized and calcium ion-incorporated surfaces. Smooth surfaces might lessen the risks for biofilm infections, but it would be feasible to alter their chemistry or other properties, making implants the main factor to take into account. Additionally, despite the fact that smooth surfaces are normally designed to integrate with soft tissues, there surfaces alterations (both topographical and chemical) that aim to activate the soft tissue's cells and biological processes. Because bacteria are regarded as cells as well, their stimulation and/or adherence may also rise. Compared to turning or polishing benefits for integrating soft tissues are suggested by surfaces that have been modified to produce a nanoporous TiO_2 surface using sol-gel dip coating.
Keywords: *Surface Modification, Plasma Spray Coating, Grit Blasting, Sol -Gel Technique, SLA, Ion Plating.*

Received 02.08.2022 Revised 21.09.2022 Accepted 26.10.2022

INTRODUCTION

A new era of oral rehabilitation began when Branemark presented the idea of osseointegration as a reliable technique for implant anchoring for the support of dental prosthetics. The idea of osseointegration came, the traits of interface among bone and implant, and feasible ways to improve it, had been of particular hobby in dental implant research [1].Including form, shape, configuration, surface macrostructure, and macro irregularity [2]. Currently, there is also a nano level of implant surface topography in addition to macro and micro levels. In the past ten years, microtopography has been viewed as the most crucial component of a successful implant procedure [3].The goals of such development for Modifications to implant surfaces are designed to enhance clinical outcomes. In zones with deficient bone density or quality, to hasten bone healing, and to eventually enable early or rapid loading protocols [4]. The three types of surface modification techniques used for implants are mechanical, chemical, and physical [5]. The three mechanical processes that will be most frequently used are machining, polishing, and blasting. Chemical vapor deposition, peroxide treatments, acid or alkali forms of treatment, and are examples of chemical procedures for modifying implant surfaces. Plasma spraying, sputtering, and ion deposition are examples of physical techniques for altering implant surface morphology. Recent developments in implant surface modifications include the use of bone-sparing medications such bisphosphonate and bone-promoting medications like simvastatin which promote bone formation [6].

REASONS FOR SURFACE MODIFICATION

It has long been known that the basic characteristics for biomaterials, including such as regulated process ability, elastic modulus, non-toxicity, and fatigue resistance, are indeed very relevant. Selecting which biomaterials are ideal for a certain biological application. The initiation of biological reactions, interactions in between the biological environment and the surfaces with the artificial materials, and the precise response paths that the body chooses to pursue are all events that take place after implantation. The material surface has a significant impact on how synthetic medical technologies affect the biological environment. The process used to manufacture titanium implants frequently results in a surface layer that is oxidized, contaminated, stretched, plastically deformed, asymmetrical, and poorly defined. Since all these natural surfaces are obviously inappropriate for biomedical applications, these must be treated [7]. Adding a medicinal surface functionalization to titanium is also very important. When using titanium medical equipment, particular surface qualities that are distinct from the metal's bulk are typically needed. For instance, attaining biological integration requires having great bone formability Blood compatibility is essential for blood-contacting devices like prosthetic heart valves. Good corrosion and wear resistance are also crucial in other applications. The best surface modification techniques maintain the great bulk qualities the formability, machinability, excellent fatigue resistance, low modulus, and other properties of titanium and its alloys while increasing certain surface properties required for specific therapeutic applications.

Pre -treatment significance

An important work from Buser and colleagues which evaluated surface modification preparations of the importance by contrasting CP titanium with an electropolished surface negative control and a hydroxyapatite-coated coated positive control group, of micron-scale topography was highlighted. Prior to treatment. This study confirmed that is previous finding that Bone calcification could be accelerated and increased by surface that is micron-scale rough due to grit blasting and subsequent acid etching. Furthermore, bone accretion at cp was supported by a $TiO2$ surface that had been grit-blasted metallic implant [8-9].

SURFACE TOPOGRAPHY

1. Surface topography **-** Microtopography and Microtopography microtopography is mainly deals with the shape of a dental implant.
    a. Implant length
    b. Implant width
    c. Implant geometry
    d. Threaded/non Threaded.
2. Physiochemical- This is based on the glow discharge approach, which improves cell adhesion and tissue integration conductivity by changing, surface charge, and surface composition.
3. Morphogenic- Alter the surface morphology of a dental implant to increase cell adhersion and tissue response.
   The changes are bought by chemical or mechanical method

- Biochemical- The action is mainly by immobilize protein,on biomaterial to cause a certain cell and tissue reaction using enzymes or peptides.

ADDITIVE

- Sintering
- Plasma spraying
- Anodization
- Nano structured Surface
- Coating sol-gel
- Electrophoretic deposition
- Biomimetic deposition
- Drug incorporated

SUBSTRACTIVE -Machined /turned

- Grit blasting/sand blasting
- Acid etching
- Dual acid etching
- Laser peening
- SLA
- Electropolishing

NANOMODIFIED- Ion implantation

- Ion beam deposition
- Nano crystal coating

CA PHOSPHATE COATING [10].

METHODOLOGY

It was suggested to alter the surface's properties from turned to roughened, to to enhance the surface area and to better stabilise the implant. Methods that are additive (like plasma spraying or HA coating) or subtractive (like sandblasting) are used to prepare modified surfaces. (eg. Sandblasting, acid etching) have been used. Values for turned surfaces typically range from 0.3 to 1.0 m [11].

IN ADDITIVE METHODS

PLASMA SPRAY COATING

Due to the fact that practically all commercial HA coatings are created using this procedure, it is the most used coating technology in dental implants. It expanded the bone-implant interface's surface area and behaves like such a three-dimensional surface, which may enhance adhesion osteogenesis. The fluorapatite (FA), which can retain a significant amount ofHigh structure and morphology during the high-temperature plasma spray method and its fluorine component, is the most stable of the calcium and phosphate coatings created by plasma spraying. The crystallinity of this procedure is between 60 and 70 percent, but if the coated implant is heated to the proper temperature following the deposition process, a higher content can be produced [12]. Alkaline-modified plasma sprayed implants have been said to promote the formation and growth of more new bones, which may be advantageous. In order to improve implant success rates, shorten clinical healing durations [13].

SINTERING

A layer-by-layer object is constructed in direct metal laser sintering (DMLS), a laser-based process, powdered metals, radiating heaters, and a computer-controlled laser additive manufacturing technology. Utilizing DMLS technology, implants with bone-compatible properties can be created.

ANODIZATION

Through an electrochemical reaction, it is the procedure by which oxide layers are placed on the Ti implant surface. In this method, a Ti surface that will be exposed to In an electrochemical cell, oxidising acts as the anode and diluted acid solution as the electrolyte. The implant is significantly supported to the bone by the anodized surface.

CALCIUM SILICATE COATING BLASTED WITH PLASMA

Glasses, glass-ceramics, and ceramics based on CaO-SiO2 have reportedly shown some good bioactivity and biocompatibility. Bioactive glass was once applied to titanium and similar metals by plasma spraying. The bioactive glass coating preserves the amorphous structure and behaviour of the original glass in a hydrolytic environment [14].

SOL-GEL COATINGS

Recent research has begun on using sol-gel technology to cover dental implants. In this process. The coating process involves dipping the metal implant into a solution containing progenitors of the finished product, pulling it out at the right rate, and then heating it to create a more dense coating.

TECHNIQUE

For attaching to the metallic substrate, the coating is heated at 8000–9000 C to melt the carrier glass. This procedure is repeated until a HA/glass combination coating that is relatively thick (e.g. 100 m) can be produced.

1. High strength and small crystalline size are advantages.
2. Possibility of covering porous substrates uniformly.

In order to give crystalline ceramic materials the best density and strength possible, hot isostatic pressing is performed. With the use of pressure and heat, this technique transforms a solid ceramic of considerable strength (such as alumina or HA). The implant surface is coated with HA powder, after covering the powder with inert foil to encourage uniform densification, pressure and heat are then applied.

DRAWBACKS

1. Eexorbitant
2. Requirement to take out the inert foil or other encasing material.
3. Contamination's potential.

Plasma-sprayed hydroxyapatite coating - Because manufactured hydroxyapatite resembles. It is thought to be a bioactive material since it is the mineral phase of true hard tissues. One way to conceptualize bone is as an extracellular material with inorganic infill. With submicron-sized crystals. It has been postulated and scientifically proven that HA can be used as an orthopedic biomaterial because over 70% of bone's mineral portion has a HA-like structure [15].

IN SUBTRACTIVE METHODS

GRIT BLASTING

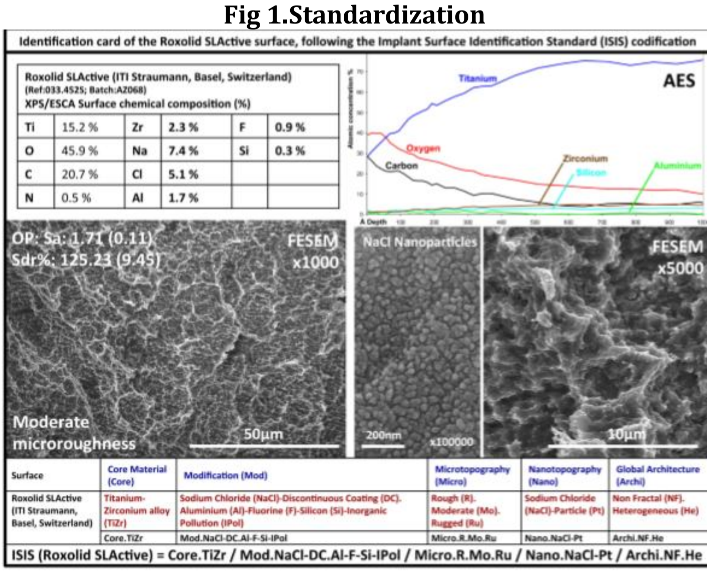
Grit blasting is a method for roughening the surface of implants by projecting ceramic or silica particles onto the implant surface under pressure. These procedures typically involve the use of materials like sand, hydroxyapatite, alumina, or TiO2 particles [16]. Acid etching is always done following grit blasting to remove the remaining blasting debris. Therefore, one method for embedding surface contaminants on substrates is through grit blasting [17]. Zirconia particles applied to a titanium surface by blasting were discovered to have a surface microhardness that was significantly higher than a controlled polished titanium surface [18]. With various treatments, Al-Radha and colleagues examined the impact of bacterial adherence on a number of titanium implants. When compared to other surface treatments, the findings showed that titanium that had been ZrO2-blasted had more bacterial adherence [19].

ACID ETCHING
By eliminating the implant's Acid etching damages the surface grains and grain boundaries of the implant. To become pitted. Selective removal of material is performed because the etching process is more sensitive to particular phases and contaminants than to others. the volume of the substance, the microstructure of the surface, the acid, and the time spent soaking all have an impact on the final roughness [20].Given that the normal Sa values range from 0.3 to 1.0 m, the surfaces are typically regarded as minimally rough. To do this, several mixtures of baths containing nitric acid, sulfuric acid, and hydrochloric acid are used. The acid etching process is influenced by the roughness preceding to etching, the acid mixture, the water temperature, and the etching time. In order to generate a surface that is microtextured (as opposed to microtextured), a dual acid-etched method has been suggested. This surface may be more likely to provide the desired outcomes. This is due to the fact that this dual acid-etched surface showed increased platelet gene adhesion and extracellular gene expression. MIS implant, for instance [21].

SANDBLASTED AND ACID ETCHED SURFACE (SLA)
This procedure is used to achieve a dual surface imperfection and removal any imbedded blasting material. Applying a powerful acid to the surface after blasting is how SLA causes surface erosion. In order to promote surface roughness and osseointegration, this treatment progressively uses blasting, Using large-grit sand and acid etching, pits of various sizes are produced. Suggesting a rise in surface area and surface roughness. As a result, it was discovered that the SLA-treated surface was helpful for enhancing cell proliferation and tissue integration. Following repeated grit blasting and alkaline treatment. Demonstrated that the surface had a high shear strength, promoting osseointegration and early bone development during the initial stage of the implantation, enhanced morphology and good bioactivity led to successful osseointegration, according to a recent experiment on a two-step chemical treatment (acid-alkali) [22]. Human osteoblasts were also demonstrated to develop wonderfully on the SLA surface, creating more room for cell adhesion and proliferation. Sandblasting usually results in rough and variable surface morphology for SLA; however, acid etching produces a more uniform surface with tiny micro pits (diameters of 1-2 m).

ION PLATING
During ion plating, a rapid irradiation of particles alters the substrate surface and has an impact on the formation of films (fig 1). Typically, dynamic particles are obtained from plasma, a target made of a compound or alloy, plasma or a suction arcs, or specialized ion sources [23].

Fig 1.Standardization



CONCLUSION

Applying subsurface alterations techniques as well as its alloys mechanical, chemical, and biological characteristics are improved for use in biomedical applications. Depending on how the Using mechanical, chemical, and physical methods, changed layers can form on the surface of titanium and its alloys. When the Titanium and its alloys' surfaces are altered using the right surface modification technology, the properties of those materials can be improved to some extent. As surface engineering advances, more fresh methods of the development of surface modification to enhance the qualities of titanium and its alloys for use in therapeutic applications. Although the surfaces of titanium implants can be made rougher mechanically. Surface films on titanium implants can be created using a number of different techniques, each of which has a variable in terms of shape, thickness, microstructure, and chemical structure. Oxide layer thickness and surface roughness development during thermal treatments depend on both temperature and time. On the other hand, laser surface treatment can be utilised to create the without compromising the implant surfaces, achieve the effective surface roughness. The methods covered in this article are well known and are frequently employed by companies that produce dental implants in modern times. Despite the fact that Dental implants have been made using these methods with success. With a variety of surface topographies, it is still unclear how various surface topographies will affect osseointegration and long-term biological compatibility. However, there is a lot of ongoing research in this field, and a number of new tools and techniques will soon be available to create. In three different biological settings, oral implants must work in conjunction with bone, soft tissue, and microbial biofilms. The area of the implant that is intended to integrate with bone has the roughest surface, making it the most unstable location for the growth of biofilm. Anodization and the addition of calcium ions to titanium surfaces may be able to make up for some surface wear while still functioning well in bone tissue.

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CITATION OF THIS ARTICLE

K Solanki, R Sanan, A Nagpal, B Raina, S S Phukela, P Ritwal. Surface Treatment in Dental Implants. Bull. Env.Pharmacol. Life Sci., Spl Issue [2]: 2022: 544-549