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REVIEW ARTICLE

Surface Treatment In Implantology: A Review

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ABSTRACT
Dental implants are the promising treatment option now available in dentistry to replace a missing tooth. The success and failure of an implant depend up on criteria like local factor, biological factors, factors influenced by clinician and implant related factors. Implant design and surface condition have a great influence on the Osseointegration. Researchers are going on to find out the best way to improve surface condition of an implant. This article reviews the literature of various current innovations on the implant surface treatments.
Keywords: Surface Treatment, Implantology, Edentulism, Osseointegration

INTRODUCTION
Implantology is a branch of dentistry that has made countless advances over the past decades. The basic principles of integrated osteo-implantology have undergone significant changes that are modifying the therapeutic modalities faced by the profession. Obtaining excellent results in oral rehabilitation, solving aesthetic, functional and psychological problems in both partial and total edentulism.In various clinical situations, thanks to all the results obtained, it is possible to anticipate loading times, satisfying expectations and consequently increasing the patients confidence in these treatments. Implant-supported prostheses, actually, have significant advantages over adhesive or mucous ones, because the titanium implant solicits the bone stimulating the maintenance of its vertical and horizontal dimensions in a similar way to natural teeth.[1,5] The interaction between the implant surface and the living body begins soon after the placement of the biomaterial in the body, and it has always been a challenge to determine the optimal modification to accelerate the biologic events which lead to faster osseointegration. In present scenario dental implants are one of the most advanced treatment option in rehabilitation of partially or completely edentulous patients. Dental implants have benefits over the conventional treatment modalities like preservation of bone, preservation of adjacent tooth, esthetics, durability etc. Titanium implants have the magical ability to anchor with bone i.e. osseointegration. The long term success rate of an implant is influenced by implant surface and implant design. So we can enhance the osseointegration by changing surface topography of an implant.

SURFACE TOPOGRAPHY
MACRO TOPOGRAPHY
MICRO TOPAGRAPHY
They mainly deal with the shape of a dental implant.
1- Implant length
2- Implant width
3- Implant geometry
4- Threaded/non Threaded.

PHYSIOCHEMICAL
This is based on glow discharge method which increase the cell adhersion property and its conductivity to tissue integration -By altering surface energy, surface charge, surface composition

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, enzymes or peptides on biomaterial for inducing specific cell and tissue response.

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, lectropolishing

NANOMODIFIED
Ion implantation, Ion beam deposition, Nano crystal coating, Ca phosphate coating, Ha Coating, Control cell, Biomaterial, interaction utilizing cell, adhesion molecule. Biomolecule with osteotrophic effect. Eg-interlukin, growth factor l and ll, platelet growth factor, BMP.

SUBTRATIVE METHOD
MACHINED SURFACE
This was initially used technique to modify implant surface. Implant will only submitted to decontamination process after the turning process. This surface is also called machined or smooth implant. As morphology of implant play a vital role in osseointegration. It is necessary to modify the surface by additive or subtractive method.

GRIT BLASTING OR SANDBLASTING
This is the process by which an abrasive media is accelerated through a blasting nozzle by means of compressed air. This process will make surface irregularity. Factors effecting irregularity are blasting pressure, time, distance from blasting nozzle etc .Roughening of titanium surface consist blasting the implants with hard ceramic particles. Other materials which are used for sandblasting are Titanium oxide, alumina and calcium phosphate. This procedure is done with aim of increasing the surface irregularity of implant. But some time

blasting procedure can leave residual particle on surface of implant and this could modify the bone healing process.[6-8]

ACID ETCHING

This procedure is performed using bath of HCL,H_2SO_4,HNO_3 in different combination. The surface of dental implant can be roughened by etching the surface with strong acids like HCL,H_2SO_4,HNO_3 above 100°c .this process will create micro pits of 0.5-2mm.dual acid etching technique found to be more efficient to achieve desired results.

DUAL ACID ETCHING

This technique is used to increase the submicron topography these by increasing the biological property of dental implants. This is done by immersing the titanium implant in a mixture of HCL, H2SO4 and heat above100°c.Advantages of this technique is increase osteoconductive activity.

LASER PEENING

It is a newly formed technology in which we can perform a contamination free peening method. Process involved use of high intensity nano second pulses of laser beam (3-5 width) striking a protective layer on the metallic surface, melting the surface layer locally. As this process is contact less the chances of thermal, mechanical deformation of substrate is low.

SLA (SAND BLASTED AND ACID ETCHED)

The surface modification can be made by combination of sandblasting and acid etching. Blasting is done with various particles like Al_2O_3 and TiO_2 which is followed by etching with HCl and H_2SO_4. This will create a micro and macro structure modification. It has got more Osseo conductive properties and higher ability to induce cell proliferation.[9-12]

ELECTRO POLISHING

This Technique is also known as electrochemical polishing, anodic polishing or electrolytic polishing. This method removes material from a metallic work piece, which will remove the surface roughness by eliminating peaks and valleys. So this technique is used for polishing and passivation of the metallic surface. Electrolyte used for this purpose is often concentrated acid solution which has high viscosity, eg- sulphuric acid and phosphoricacid.[13-16]

ADDITIVE METHODS

SINTERING

Direct metal lasers sintering (DMLS) is a laser-based AM technique, in which an object is built layer by layer using powdered metals, radiant heaters, and a computer-controlled laser. DMLS technology can be used to fabricate implant, with property which is compatible to the bone.

PLASMA SPRAYING

This is the process of spraying molten metal on the titanium base which results in surface irregularity like valley, pores. The layer formed will be homogenous, smooth and rigid. The growth of bone to this irregularity will create a mechanical interlock and surface irregularity will increase surface area which aid in initial fixation of implant, especially in soft bone. Titanium plasma spraying is done by heating titanium to plasma form and spray this plasma on implant surface, this will improve the micro retention. HA Coating, Hydroxyapatite is a material that may form direct and strong binding between bone and implant. This is done by heating hydroxyapatite with plasma flame at temp 15000-20000K, this will be forced on to

the implant surface in an inert environment. Thickness of the coating formed is 50-200µm, roughness is 7-24µm. Coating with hydroxyapatite will increase surface area. The bone implant interface revealed to be better formed with this coating.

ANODIZATION

It is the process by which oxide films are deposited on Ti implant surface by means of an electro chemical reaction. In this process, Ti surface to be oxidized play as anode in an electro chemical cell with diluted solution of acids acting as electrolyte. Anodized surface result in strong reinforcement of implant to bone.

NANO STRUCTURED SURFACE

Produced by galvanostatic anodization of titanium in strong acids (H2SO4 , H3PO4, HNO3, HF) at high density(200 A/m2)or potential (100v)

SOL GEL COATING IMPLANTS

This method applies thin homogenous chemical distribution on the implant surface. It has got many advantages like increase toughness, early bone formation and it will improve osseointegration.

ELECTROPHORETIC DEPOSITION

This is the process which colloidal particle, such as nano precipitates which are suspended in a liquid medium migrate under the influence of an electric field and is deposited on to a counter charged electrode. Coating is simply formed by pressure exerted by potential difference between electrodes.

BIOMIMETIC PRECIPITATION

A surface treatment method in which implant surface is coated with a biomimetic agent. A biomimetic agent is an "agent /material able to replicate or imitate a body structure (anatomy) and function (physiology) (glossary of implant dentistry) It has been shown that such biomimetic coatings are more soluble in physiological fluids and resorbable by osteoclastic cells such as dentin materials.

DRUG INCORPORATED

Surface treatment of implant with antibacterial coating serves the possible way to prevent surgical site from infection. Gentamicin can be used along with HA coating. Tetracycline – HCl treatment is also an efficient method for decontamination and detoxification of implant surface**.**

NEED FOR IMPLANT SURFACE TREATMENT

- To increase the surface area
- To bring better bonding
- To increase surface roughness
- To make the make them more passive
- To remove the surface contamination

OSSEOINTEGRATION

Osseointegration is defined as the direct, structural and functional connection between a vital bone and the implant surface without the interposition of soft tissue. Likewise, the characteristics needed to achieve a rigid osseointegration were determined by Brånemark,

Albrektsson et al. in the early eighties, with studies setting out some rules to follow in relation to biocompatibility. Cooper *et al.* studied the effect of surface topography on the ability of osteoblast cultures to produce a mineralising matrix and they concluded that cells respond differently to various surfaces.20 If the implant surface is less than optimal, osteogenic potential will be reduced.21 It is not clear whether bone grows from the osteotomy site walls toward the implant surface or along the implant surface itself.22 At the microscopic level, the biomechanical interlocking between implant and bone can be influenced by the topography of an implant surface.23 Experimental studies have shown that for metallic implants with porous surfaces optimum bone growth requires a pore size between 50 and 400 μm.

BONE MODIFICATIONS AFTER IMPLANT PLACEMENT/INSERTION

The placement of an implant fixture inside the bone region must be considered dam age of the organism's integrity. Around the implant, there is always an empty micrometric space, in which complex biological phenomena are present, where from the beginning can be manifested an ischemia of the tissues with necrobiosis on the bone side. The increased vascular permeability in the intervention area results in the transfer of undifferentiated mesenchymal cells to cover the cavity between the bone and implant surface (vascular cell migration and colonization). After the fifirst four days, cell differentiation and organization of peri-implant tissue take place to allow the removal of cellular and bone debris from the necrosis removed by macrophages to begin subsequently the repair phase. The formation of the new bone follows all the phases that characterize the direct, including here the osteoblasts arrival, deposition of the osteoid tissue, formation of immature bone with interlaced fibers. During the sixth week, the primitive bone is progressively reabsorbed and then replaced by mature lamellar bone; this process leads to the formation of bone around the inserted implant.

GENERAL PROPERTIES OF TITANIUM

According to a widespread classification, implantable materials are divided into biotolerant, bioinert and bioactive. Biotolerant materials are characterized by a type of healing called "distant osteogenesis," where the ions released by the material inserted into the host interfere with the cell metabolism and lead to the production of connective tissue. Then, bioinert materials do not release ions or harmful substances that can affect the cell metabolism and do not stimulate adverse tissue reactions, therefore a "contact osteogenesis" occurs without any interposition of connective tissue. Bioactive materials produce a favorable response, facilitating bone deposition thereby establishing chemical bonds with tissue components such as hydroxyapatite or stimulatingstimulating cellular activity. While, due to their mechanical characteristics and the level of current technologies, they can only be used as coatings, because they are unable to support the forces discharged on a dental element. Various materials have been tested in the construction of dental implants, some of which are no longer used; while implantable materials now considered biocompatible are commercially pure titanium (cp Ti), titanium alloys such as (Ti-6Al-4V), Al2O3-based ceramics, hydroxyapatite and zirconia. Titanium is a well-known metal in the dental field, where its physical, mechanical and biological characteristics, in fact, allow it to be universally used for the production of crowns, bridges, prostheses and implant systems. Moreover, it has a relative density of 4.5 g/cm, reaching melting at 1677^0C, boiling at 3277 ◦C and its thermal conductivity is leveled downward (22 Wm−1 K−1).

CONCLUSION

The surface treatment in the field of implantology has shown tremendous increase in the success rate of implant. The major challenge is mostly this technique are performed in

condition different from natural condition. So the tissue reaction towards this surface treatment should be fully understood. The success of an implant is depending up on the use of various modifications in accordance with the situation to obtain maximum benefit for the patient.

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