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Implants In Osseo Integration: A Review

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Abstract

It is the most investigated area in implant logy in recent times. Evidence based data reveals that osseointegrated implants are predictable and highly successful. This process is relatively complex and is influenced by various factors in formation of bone neighboring implant surface. The present review provides the understanding of various features of osseointegrated implants.

Keywords

Osseo integration, Implants, Bone.

Introduction

It is the direct structural and functional link between living bone and the surface of a non-natural implant. It is a direct bone anchorage to an implant body, which can provide a foundation to support prosthesis; it has the ability to transmit occlusal forces directly to bone.1

Definition

"It is a process whereby clinically asymptomatic rigid fixation of all plastic material is achieved and maintained in bone during functional loading" – "Functional ankylosis**"**.3

"It is the direct anchorage of an implant by the formation of bone directly on the surface of an implant without any intervening layer of fibrous tissue."4

Bone density classification

In 1988 Misch10classified bone density groups independent of regions of jaw based on macroscopic cortical and trabecular bone. Dense or porous cortical bone is found on the external surface of the bone and comprises of the crest of edentulous ridge. Granular and fine trabecular bone are found surrounded by the outer shell of cortical bone.

D1: Compact cortical bone

D2: Thick compact to porous cortical bone on the crest and coarse trabecular bone within.

D3: Thin porous cortical bone on the crest fine trabecular bone within.

D4: Fine trabecular bone.

D5: Immature, non-mineralized bone.

To preserve a persistent level of bone remodeling, there should be appropriate local stimulation as well as crucial levels of thyroid hormone, calcitonin, and vitamin D within the system. Occlusion or occlusal force stimulus, and general health management are both important for perfect bone remodeling at the fixture locations.11

There are two basic theories regarding the bone-implant interface and retention of an end steal implants in function. They are:

1. Fibro-osseous integration supported by Linkow (1970), James (1975), and Weiss (1986.)12

2. Osseo integration supported by Bran mark (1985.)**10**

Stages of Osseo integration

In bone defects, principal fractures and in Osseointegration the healing is stimulated by any lesion of the pre-existing bone matrix. When the matrix is open to extracellular fluid, noncollagenous proteins and growth factors are released and activate bone repair takes place.

Osseo integration follows a common, biologically determined program that is subdivided in to 3 stages:

1. Incorporation by woven bone formation.

2. Adaptation of bone mass to load (lamellar and parallel-fibered bone deposition)

3. Adaptation of bone structure to load (bone remodeling).

Key factors responsible for successful Osseo integration

There are several reasons for primary as well as secondary failure of osseointegration. These failures may be attributed to an inadequate control of the six different factors known to be important for the establishment of a reliable, long-term osseous anchorage of an implanted device. These factors are:13

Implant material biocompatibility

1. Implant design characteristics.

2. Implant surface characteristics.

3. Bone density quality.

4. Surgical considerations.

5. Loading conditions

Implant design characteristic

1. Implant design refers to the 3Dorganization of the implant i.e., form, configuration, geometry, contour, surface macro irregularities and macro structure. Exactitude fit in the vital bone leads to osseointegration. At present, satisfactory long-term documentation solitary on threaded types of oral implants that have been established to function for decades devoid of clinical problems.

2. Various implant designs are cylindrical, screw shaped implants, Threaded and Non threaded

3. Cylindrical implants / press fit implants:

4. They lead to stark bone resorption due to micro movement of the implant in the bone. Alberktsson in 1993 reported that enduring bone saucerization of 1mm – first year, 0.5 mm annually and there after cumulative rate of resorption up to 5 year follow up.

Threaded implants

Documentation for long term clinical function.

Modification in the design, size and pitch of the threads can affect the long term osseointegration.

Advantages of threaded implants:

Load distribution for stress is better as the functional area is more than the cylindrical implants.

Threads enhance the primary implant stability and evade micro movement of the implants till osseointegration is reached.

The various forms of threads are: Standard V – thread, Square thread, Buttress thread.

5. The threaded portion of a screw-shaped implant has three typical regions: the top, the flank and the valley region. Of the three different sites, the top region frequently has the roughest surface.15

6. If we assume that all parts of an implant are equally important with respect to osseointegration, a proper characterization of the implant surface must include measurements made in all 3areas.Alignment of irregularities may give isotopic surface & anisotropic surface.

Wennerberg 2000 reported that improved bone fixation (osseointegration) will be attained with implants with an enlarged isotropic surface as matched to implant with turned anisotropic surface structure.16

Different machining process results in different surface topographies:

7. 1. Turned surface / machined surface.

8. 2. Hydroxyapatite coated surface

3. Acid etch surface – Hydrogen Chloride (Hcl) &Sulfuric acid(H2 SO4).

4. Blasted surface – Titanium dioxide (Tio2) /Aluminum oxide **(**Al2 -O3)particles.

5. Blasted + Acid etch surface(SLA surface) ; AL2O3 Particles, Hcl, H2SO4 Tri calcium phosphate, Hydrogen fluoride Nitrate

6. Titanium plasma sprayed surface

7. Nano sized hydroxyapatite coated surfaces.

With respect to the deceptive topography there is strong documentation that most plane surfaces don't result in intolerable bone cell adhesion. Such implants do consequently get anchored in soft tissue even with the best material used.

Carlson et al published evidence of dominance of the threaded design in osseointegration compared with plates and several irregular implant shapes.17

Kasemo and Lausmaahave summarized standpoints on the implant surface and made 3 important conclusions: 18

(1) It is not possible to predict how surface change status affects the long-term function of an implant.

(2) The surface status of a particular implant material may vary widely depending on its preparation and handling.

(3) The surface status of implants is crucial for in vivo function and should therefore be specific and standardized.

Osteo promotion

It is the procedure to enhance the formation of bone approximating the implant surface using bone regeneration techniques (using Polytetrafluoroethylene membrane).Bone growth factors like Platelet-derived growth factor (PDGF),Insulin-like growth factor (IGF), Platelet-rich plasma, transforming growth factor (TGF – B1)stimulates osteoprogenitor cells, enhance the bone growth.

Stefini CM et al (2000) recommend applying PDGF and IGF on the implant surfaces afore placing in to cervical bed. This technique showed improved wound healing and prompt osseointegration.19

Indications

1. Localized ridge augmentation preceding to placement.

2. Situations with deficient alveolar bone volume.

3. Treatment of peri implant bone defect.

Hyperbaric oxygen therapy (HBO):

HBO uplifts the partial pressure of oxygen in the tissues. Granstrom G (1998) reported that HBO can counteract some of the negative effect from irradiation and act as a stimulator for osseointegration.20

Role of HBO in Osseo integration

1. Bone cell metabolism
2. Bone turnover
3. Implant border and the capillary network in the implant bed (angiogenesis)

Osseointegration from the perspective of inter molecular forces:

According to Albrektsson et al. Calcified tissue extents within 50 A0 of the implant surface. The metal surface is a tremendously polarizable titanium oxide coating altered by auxiliary filths from the majority metal phase.21,22

With time the titanium oxide surface blends with material from contiguous tissue, and a thin layer of ground substance of cellular origin is engaged on the implant so as to reinforce bone tissue and titanium. The interactions are electrostatic rather than hydrophobic or Van Der Waals interactions. To a charged body the highly polar oxide coating delivers a sturdily attractive substitute to water. The numerous configurations of titanium and oxygen possibly occur on such a surface and offer a widespread variety of adsorbent locations to attract innumerable ranges of charges that possibly reside on the water – soluble ground substance. V. Adrian Parsegian even expected spots of strong interaction involving charge assemblages such as those seen between dimerizing proteins.23

Patient Selection and Preparation

The surgeon with judgment should carefully evaluate the patient prior to recommending implants. Evaluation should include:24,21

- Consultation.
- Oral examination
- Radiographic assessment.
- Diagnostic casts mounted on an appropriate articulator.

Several matters merit attention during the evaluation

Stage

- Age
- Medical status
- Patient motivation
- Concurrent drug therapy
- Informed consent

All patients are recalled at least annually for examinations, which include the following:

- Patient's opinion of the treatment result
- Bone characteristics
- State of bridge occlusion and stability
- State of oral hygiene
- Mechanical component conditions

Conclusion

The tooth is attached to its adjacent bone by soft tissue, an extremely differentiated periodontal membrane. It seems natural; consequently, that early investigators of oral implants appealed that the soft tissue seen aroundtheir devices was a duplication of nature and accordingly would lead to enduring function. Conversely, certain histologic differences between the proper ligament and the soft tissue were observed in nearby metallic devices, this led to the formulation of new nomenclature named osseointegration. Even though implantologyis the prime areas of the present research, a comprehensive and thorough understanding of bone–implant interface interactions is important for the dental surgeon to give the patient finest promising clinical care after understanding patients bone characteristics', thus enabling a treatment plan which follows the principles and gives better clinical expectedness.

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