Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 7, Issue, 12, pp. 14696-14699, December, 2016

ISSN: 0976-3031

International Journal of Recent Scientific Research

Review Article

OSSEOINTEGRATION IN DENTAL IMPLANTS: A REVIEW

Sarve P H[1]*., Kulkarni D[2]., Shetty L[3]., Bongulwar R[1]., Akolkar A[1] and Khandelwal N[1]

[1,2,3]Department of Oral and Maxillofacial Surgery, D Y Patil Dental College and Hospital Pune

ARTICLE INFO

Article History:

Received 17th September, 2016
Received in revised form 21st October, 2016
Accepted 05th November, 2016
Published online 28th December, 2016

Key Words:

Osseointegration, Dental Implant Osseointegration, Oral Implantology. Osseointegration in Dental Implants.

ABSTRACT

Osseointegration refers to a direct structural and functional connection between living bone and the surface of a load-carrying implant. Currently, an implant is considered as osseointegrated when there is no progressive relative movement between the implant and the bone with which it has direct contact. A direct bone contact as observed histologically may be indicative of the lack of a local or systemic biological response to that surface. It is therefore proposed that osseointegration is not the result of an advantageous biological tissue response but rather the lack of a negative tissue response. The rationale of the present review is to know the mechanism of osseointegration for successful implant placement.

INTRODUCTION

'Oral Implantology' Implant Dentistry is the science & disciple concerned with the diagnosis, design, insertion, restoration and or management of the alloplastic or autogenous oral structures to restore the loss of contour, comfort, function, esthetics, speech &/or health of the partially or completely edentulous patient as stated by the American Academy of Implant Dentistry(1990).

An 'Oral or Dental Implant' is a biologic or alloplastic biomaterial surgically inserted into the soft or hard tissues of the mouth for functional or cosmetic purposes, as stated by Joblonsky (1982). Osseointegrated oral implants had a clinical breakthrough during the 1980's. In the past regarded as a biological impossibility, a direct bone anchorage of metallic oral implants was first suggested by Per-Ingvar-Branemark (1969), a Biotechnology professor at the University of Gothenberg, and Albrektsson (1981) later presented the first definition of osseointegration as, 'The direct contact of the living bone with the surface of an implant at the light microscopic level of magnification'. (Branemark PI, 1985).

In 1986, American Academy of Implant Dentistry defined osseointegration as 'Contact established without interposition of non-bone tissue between normal remodeled and an implant entailing a sustained transfer and distribution of load from the implant to and within the bone tissue' (Branemark P I, 1983). The successful replacement of the lost natural tooth by means of tissue integrated implants represents a major advance in clinical treatment.

Osseointegration which can also be defined as the predictable long term anchorage of the tooth root analogues to the bone has an interface that consists mainly of bone tissue. This bone anchorage is so strong that it enables the fabrication of a free standing fixed prosthesis. Thus, osseointegrated implants can support prosthesis with its own fixtures threaded into the jaw bone without relying on the natural dentition. This new concept attracted a great deal of attention of practitioners all over the world. It was rapidly accepted on a global scale & has drastically changed the treatment planning point of view.

History of Osseointegration: The origins of Osseointegration go back to the early 1950's when the Swedish professor, Per-Ingvar Branemark first began conducting experimenting with titanium implant chambers to study blood flow in rabbit bone. He discovered that the bone had integrated so completely with the implant that the chamber could not be removed. Branemark called the discovery "Osseointegration" (Albrektsson *et al*, 1989; John B, 1989).

In dentistry implementation of osseointegration started in the mid-1960s as a result of Branemark's work. In the mid 1960's, he began his first successful experiments on humans. Indeed,

*Corresponding author: Sarve P H
Department of Oral and Maxillofacial Surgery, D Y Patil Dental College and Hospital Pune

his first patient went on to live another 40 years with the original implants still in place and functioning well (Albrektsson *et al*, 1989; John B, 1989).

In 1965 Branemark, who was at the time Professor of Anatomy at the University of Gothenberg, placed dental implants into the first human patient - Gosta Larsson. This patient had a cleft palate defect and required implants to support a palatal obturator. Gosta Larsson died in 2005, with the original implants still in place after 40 years of function (McClarence E, 2003).

At first very few fellow scientists took Branemark very seriously and there was little acceptance of osseointegration as a viable treatment. In Sweden he was even openly ridiculed at scientific conferences. Eventually an emerging breed of young academics started to notice the work being performed in Sweden and at a Toronto Conference in 1983 the worldwide scientific community finally began accepting Branemark's work. Today osseointegration is a highly predictable and commonplace treatment. (Branemark PI, Zarb GA, Albrektsson T, 1985)

Mechanism of Osseointegration: The healing process with the Branemark system is the same as the normal bone heals either primary bone healing of secondary bone healing. In primary bone healing, there is well-organized bone formation with minimal granulation tissue formation, this type of healing is ideal for implant placement. Secondary healing occurs where a large defect or large fracture site precludes close approximation of the two sites. In contrast to primary bone healing, the secondary bone healing may have granulation tissue and infection at the site, prolonging the healing period (Cruess RL, Dumont J, 1985).

Initially, blood is present between the fixture and bone, then blood clot forms. The blood clot is transformed by phagocytic cells, such as polymorphonuclear leukocytes, lymphoid cells and macrophages. During this period, formation of the procallus occurs containing fibroblasts, fibrous tissue and phagocytes.

The procallus becomes dense connective tissue and mesenchymal cell differentiate into osteoblasts and fibroblasts. The connective tissue is referred to as callus, including osteoblasts that appear on the fixture surface. Osteogenic fiber formed by osteoblasts has a potential to calcify. New bone penetrates and the new bone matrix is called bone callus. The new bone matures, increasing in density and hardness. About this time, the prosthesis is attached to the fixtures and with stimulation, bone remodeling occurs. Occlusal stresses stimulate the surrounding bone and the osseointegrated fixtures can withstand masticatory functions.

Osseointegrated fixtures under occlusal loads are surrounded by cortical and spongy bone. The cortical bone-to-fixture surface interface has canaliculi participating in electrolyte transportation near the oxide layer. A network of collagen bundles surround the osteocytes and insert into a glycoprotein layer. The haversian bone is well organized and forms osteon (Jayesh RS, Dhinakarsamy V., 2015).

Osseointegration in spongy bone occurs as bone trabeculae approach the fixture and come into intimate contact with the oxide layer. Blood vessels providing nutrition and bone remodeling occur at the bone trabeculae and surround the fixture surface. Fibroblasts and osteoblasts increase in number and change in shape when closer to the fixture surface, then attach to the oxide layer. Ground substance forms and fills spaces between the bone trabeculae, these fuses with the oxide layer. This phenomenon is similar to that observed in the microstructure of bone in healthy individuals and provides evidence for the bone tissue adaptation to titanium material (Schenk R K, 2000).

The histological considerations deals with the biological seal, that occurs between the implant and the surrounding tissues, and the bone-to-implant interface (Fig 1, 2).

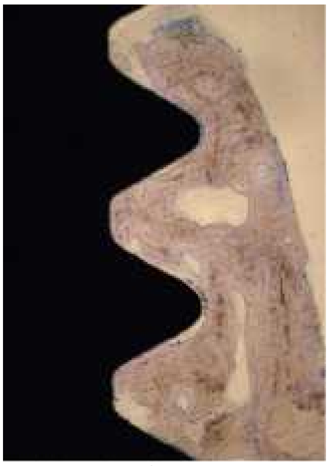

Figure 1 Histological section of Osseointegration seen under light microscopic level.

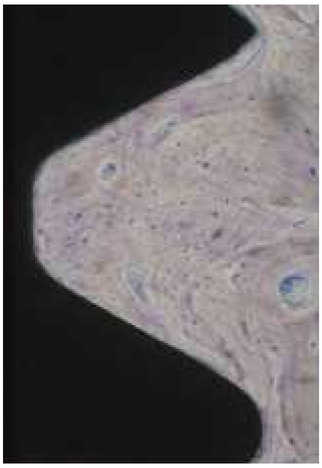

Fig 2 Higher power micrograph showing almost total bone to implant contact.

Biological Seal

During the developmental years, it was recognized that implants were successful and survived for extended periods of time in the hostile environment of the oral cavity, hence there had to be an effective biological seal between the implant material and the tissues of the jaws. It became obvious that the role of the gingival epithelium and the its interface with the implant posts were of considerable importance because initial breakdown were usually seen first around the posts. Weinmann theorized the concept of a seal around implants (Alva H. 2013).

A systematic scientific study to investigate this seal phenomenon was carried later using a combination of light microscopy and electron microscopy, they were able to show that the gingival epithelium regenerated a series of epithelial cells following surgery that were consistently similar to those seen in the natural tooth crevicular epithelium and junctional epithelial zones (Alva H. 2013).

The concept of the role of the gingival epithelium in forming a biologic seal plays an important role in implant dentistry. All dental implants, whether endosteal, transosteal or subperiosteal, must have a superstructure or coronal portion supported by a post that must pass through the sub mucosa (lamina propria) and the covering stratified squamous epithelium into the oral cavity. This creates a ‘weak-link’ between the prosthetic attachment and the predicted bony support of the implant. This zone is the area where initial tissue breakdown begins that can result in eventual tissue necrosis and destruction around the implant. The biologic seal thus becomes an important and pivotal factor in dental implant longevity. It serves as a physiologic barrier and is effective to prevent the ingress of bacterial plaque, toxins, oral debris and other deleterious substances. All these agents are known as initiators of tissue and cell injury and must be prevented from gaining access into the internal environment of the implant device (Alva H. 2013). If the seal is violated, it is probable that the adjacent soft tissues will become inflamed. This will be followed by osteoclastic activity of the underlying hard tissue and chronic resorption of the supporting bone. With continued loss of the supporting bone, the discrepancy will fill with granulation tissue and the implant will become increasingly mobile, resulting in the entry of the bacterial toxins and degenerative agents further into the internal environment surrounding the implant. Finally, sufficient destruction will occur to give rise to an acute suppurative inflammation or acute inflammation with pain, particularly upon mastication, or extensive mobility that renders support of the dental prosthesis impractical. If degenerative processes are allowed to progress to this extent, the only effective treatment is removal of the implant and debridement of the site (Alva H. 2013).

Seal Formation

The biologic formation of this transmucosal seal indicates that a series of events occur following implant surgery. The attached gingival regenerates around the implant forming an epithelial “cuff”, more appropriately termed the free gingival margin. The epithelium regenerates into this sulcus forming a nonkeratinized (crevicular) epithelium and a zone of epithelial cells at the base of the sulcus that interfaces the implant surface. These regenerated cells have the same morphology as the junctional epithelium cells seen around natural teeth. These epithelial cells at the base of the sulcus produce a series of biologic attachment structures. In addition, epithelial cells and the various component layers are the lamina lucida which lies next to the epithelial cell plasma membrane, the lamina densa, followed by the sub-lamina lucida and a glycosaminoglycan structure on the implant called the linear body.

Although, collagenous components of the linear body cannot physiologically adhere to or become embedded into the biomaterial as they do in the living cementum of the tooth, the high content of glycosaminoglycans in the linear body that coats the dental implant has sufficient “stickiness” or gluelike properties to form a biologically active and trauma-resistant attachment at the base of the regenerated gingival sulcus (Alva H. 2013).

Bone to Implant Interface

The term interface is defined as, a plane forming the common boundary between two parts of matter or space. The interface may represent a discrete boundary between the two materials or it may consist of a region or zone of interaction between the two materials. The interface that exists between a dental implant and bone is an example of the latter.

The implant to tissue interface is an extremely dynamic region of interaction. This interface completely changes character as it goes from its genesis (placement of an implant into the prepared bony site) to its maturity (healed condition) (Fig 3).

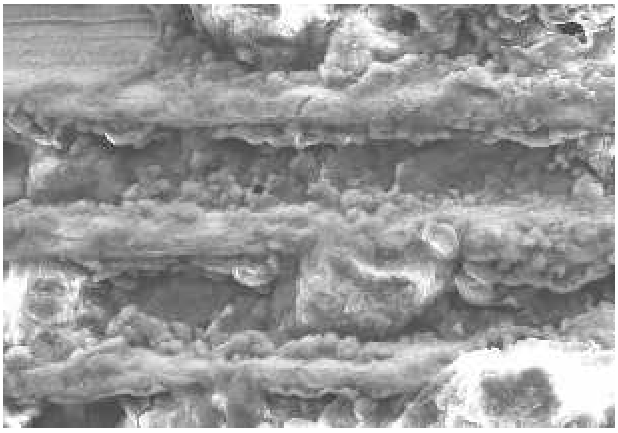

Figure 3 Bone to implant interface seen after 28 days of osseointegration

Fibro-Osseous Retention Vs Osseointegration

The two main basic means of retention of an endosteal dental implant in function are fibro-osseous retention and osseointegration. According to the American Academy of Implant Dentistry (AAID) Glossary of Terms (1986) the term fibro-osseous integration is defined as tissue to implant contact: interposition of healthy, dense collagenous tissue between the implant and bone. A proponent of fibro-osseous theory of implant fixation, Weiss (1997) defends the presence of collagen fibers at the interface between the implant and bone and interprets it as a peri-implant membrane with an osteogenic effect. He believes that the collagen fibers invest the implant, originating at a trabecula of cancellous bone on one side, weaving around implant, and reinserting into trabecula on another side. When function is applied to the implant, tension is applied to the fibers; forces closet to the implant interface cause compression of the fibers, with a corresponding tension on fibers placed or inserting into trabeculae. The difference between the inner and outer aspect of component of the connective tissue results in bioelectric current, and this current (a piezoelectric effect) induces differentiation into connective tissue components associated with bone maintenance (Davies JE, 1998)

Osseointegration Vs Biointegration

As a result the terminology used to further define retention means of dental implants has been altered to osseointegration versus biointegration. In 1985 dePutter *et al* observed that there are two ways of implant anchorage or retention: mechanical and bioactive.

Mechanical retention basically refers to the metallic substrate systems such as titanium or titanium alloys. The retention is based on undercut forms such as vents, slots, dimples, screws and so forth, and involves direct contact between the dioxide layer on the base metal and bone with no chemical bonding.

Bioactive retention is achieved with bioactive materials such as HA, which bonds directly to bone, similar to ankylosis of natural tooth. Bone matrix is deposited on the HA layer, as a result of some physiochemical interaction between the collagen of bone and HA crystals of implants as given by Denissen *et al* in 1986(Bikramjit Basu 2010).

CONCLUSION

Osseointegration is the primary requisite for success of dental implants. Complications can be avoided by accurate diagnosis, proper treatment planning, surgical and biological considerations. A well osseointegrated implant shows good retention, stability and fulfils good functional needs over the time.

References

1. Branemark PI. Osseointegration and its experimental background. *J Prosthet Dent* 1983; 50(3): 399–410.
2. Albrektsson, Tomas, Zarb, George A. The Branemark osseointegrated implant. Chicago: Quintessence Pub. Co. 1989.
3. Beumer John, Lewis Steven. The Branemark implant system: clinical and laboratory procedures. St. Louis: Ishiyaku Euro America. 1989.
4. Close to the Edge - Brånemark and the Development of Osseointegration, edited by Elaine McClarence, Quintessence 2003.
5. Albrektsson T, Zarb GA, Worthington DP, Eriksson R. The long-term efficacy of currently used dental implants. A review and proposed criteria of success. *Int J Oral Maxillofac Implants* 1986; 1:11-25.
6. Branemark PI, Zarb GA, Albrektsson T. Osseointegration in clinical dentistry. Chicago: Quintessence Pub. 1985.
7. Cruess RL, Dumont J. Healing of bone. In: Newton CD, Nunamaker DM, editor. Textbook of small animal orthopaedics. Philadelphia: J.B. Lippincott Company; 1985. p. 35-63.
8. Jayesh RS, Dhinakarsamy V. Osseointegration. *J Pharm Bioallied Sci*. 2015; 7(Suppl 1): S226–9.
9. Clarke B. Normal Bone Anatomy and Physiology. Clinical *Journal of the American Society of Nephrology* : CJASN.2008; 3(Suppl3): S131-S139doi: 10.2215/CJN.04151206.
10. Albrektsson T, Sennerby L. State of the art in oral implants. *J Clin Periodontol*. 1991; 18:474-81.
11. Schenk RK, Buser D. Osseointegration: A reality. Periodontol 2000. 1988; 17:22-35.
12. Alva H, Prasad KD, Prasad AD. Bioseal: The physiological and biological barrier for osseointegrated supported prosthesis. *J Dent Implant* 2013;3:148-52
13. Davies JE. Mechanisms of endosseous integration. *Int J Prosthodont* 1998; 11:391–401.
14. Bikramjit Basu, Dhirendra S. Katti, Ashok Kumar, textbook of advanced biomaterials: fundamentals, processing and applications, 2010.

****

How to cite this article:

Sarve P H *et al*.2016, Osseointegration In Dental Implants: A Review. *Int J Recent Sci Res.* 7(12), pp. 14696-14699.