International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor (2018): 7.426

A Novel Approach in Implant Dentistry - LIGAPLANTS

Jibi J[1], Rao BL[2], YSS Sruthi[3], Pratyusha T[4], Chitra C[5]

[1, 3, 4, 5]Postgraduate Student, Department of Prosthodontics, Lenora Institute of Dental Sciences, NTR University, Andhra Pradesh
[2]Professor & Head, Department of Prosthodontics, Lenora Institute of Dental Sciences, NTR University, Andhra Pradesh

Abstract: ***In this modern era, implants have outmatched fixed and removable partial dentures for replacing missing teeth. Implants are now in currently use because of their long term survival rate. Still, problems exist with these implants as they lack periodontal ligament. Any inflammation around these implants may cause bone loss than does the inflammation around the natural tooth with periodontal ligament. This can be solved if implants with PDL (periodontal ligament) are developed and can be achieved by Ligaplants which are nothing but a combination of PDL cells with implant biomaterial. Hence this review article aimed to discuss the benefits of periodontio-integrated implants over osseointegrated implants.***

Keywords: Periodontal ligament, Osseointegration, Implant, Periodontium

1. Introduction

Dental implants have become a popular and effective way to replace missing teeth and have changed the face of dentistry over the last 25 years.[1] The boom in implant dentistry is attributed to a combination of various reasons like prolonged life span of aging individuals, failures associated with removable and fixed prostheses, advantages and predictable outcomes associated with use of implants.[2]

The **periodontal ligament**, commonly abbreviated as the **PDL**, is a group of specialized connective tissue fibers that essentially attach a tooth to the alveolar bone within which it sits. Periodontal ligament is also known as desmodont, gomphosis, pericementum, dental-periosteum, alveolodental ligament, periodontal membrane. Apart from anchoring of tooth, PDL progenitor cells help in alveolar bone formation and remodeling.[3]

Implants are retained in oral cavity by virtue of osseointegration i.e direct contact between living bone and the surface of a load carrying implant at histological level.[1] Osseointegrated implants are the ones which are currently in use because of their long term survival rate but they too poses problems as they lack periodontal ligament. Many strategies have been experimented to improve the osseointegrative property of the implant for example surface modification to improve the mechanical, physical, and chemical characteristics of the implant, modification of shape and design of implant, alteration of surface topography, nanostructured surface coatings or addition of growth factors to implant surface.[2,4]

To overcome these problems recent scientific research developed an implant with PDL, achieved by combination of the PDL cells with implant biomaterial and named it as LIGAPLANTS.[2] There is very less literature available on Ligaplants. Keeping this in mind we reviewed the properties, procedure of obtaining ligaplants, advantages and disadvantages.

Ligaplants
Implants with PDL are placed in the extraction socket of the missing tooth, thereby facilitating the surgical procedure. Natural implant anchoring might also be compatible with further growth and development of the alveolar bone housing, and it may allow tooth movements during orthodontic therapy. Ligaplants have the capacity to induce the formation of the new bone, when placed in sites associated with large periodontal defects.[2,3][Figure 1]

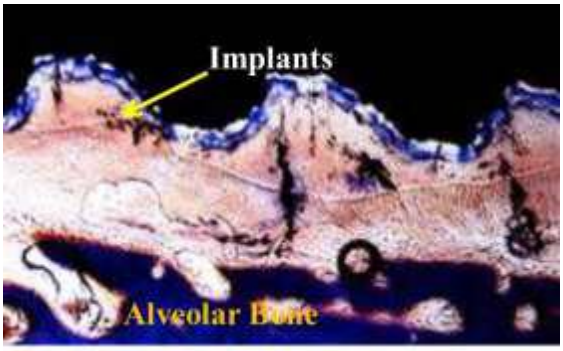

Figure 1: Ligaplants[2]

Properties of ligaplants
PDL cells distributes forces, elicited during masticatory function and other contact movements to the alveolar process via the alveolar bone proper.[2]

It gives the tooth some movement in the socket by acting as a shock absorber.[2]

Proprioception is also provided by ligaplants.[2]

It also homes vital cells such as osteoblasts, osteoclasts, fibroblasts, cementoblasts, and most importantly undifferentiated stem cells which are osteoconductive in nature.[2]

Procedure of obtaining Ligaplants
Transplantation of tooth with double PDL stimulation is one of the best examples of its healing capacity. The donor tooth is extracted and immediately replanted in its original alveolus, 14 days before transplantation. Cell proliferation and differentiation is seen as this deliberate trauma triggers a healing process within the PDL. The transplantation of the tooth can be performed with millions of cells full activity

attached to its root by new Sharpey's fibres after 14 days, when the cell culture reaches its peak of activity.[1]

A similar Cell culture around an artificial root using tissue engineering techniques are now used.[1]
To obtain ligaplants there are 3 steps-

1) Temperature responsive culture dishes preparation: On-to polystyrene culture dishes, N-isopropylacylamide monomer in 2-propanaol solution was spread. Then these dishes were subjected to electron beam irradiation with an Area Beam Electron Processing System. The dishes were then rinsed with cold water to remove ungrafted monomer and then sterilized with ethylene oxide.[1,3]
2) Cell culture and cells: From an extracted tooth human1. periodontal ligament cells were isolated. From the middle third of the root periodontal tissue was scraped with a2. scalpel blade after extraction. The harvested tissue was3. placed into culture dishes containing = Dulbecco's4. modified Eagle's minimal essential medium, supplemented with 10% fetal bovine serum and 100units/mL of penicillin-streptomycin.Then,in a humidified atmosphere of 5% CO_2 at 37°C for 48 hours those outgrowth cells were cultured to allow attachment1. of the cells to the dishes. The debris were eliminated by washing the dishes and the medium has to be changed three times per week. Human periodontal ligament cells were placed on temperature-responsive culture dishes (2. 35 mm in diameter) at a cell density of $1x10^5$ and3. cultured at 37°C supplemented with 50mg/mL ascorbic acid 2-phosphate,10nM dexamethasone and 10nM ß-glycerophosphate that function as an osteodifferentiation medium to harvest the cell sheet.[1,3]
3) PDL cells culturing in a bioreactor: A hydroxyappatite (HAP) coated titanium pin, was placed in a hollow plastic cylinder leaving a gap of 3mm around the pin. Through the gap culture medium was continuously pumped. Single cells suspension, obtained from human, was seeded first into plastic vessels under a flow of growth medium for 18 days.[1,3][Figure 2]

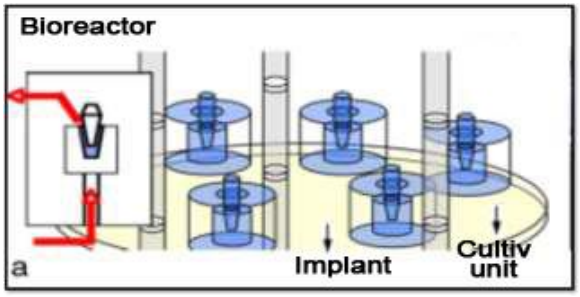

Figure 2: Bioreactor

Osseointegration versus PDL integration
PDL permits micro movements and acts as a shock absorber which causes qualitative difference in force distribution between implant supported prostheses and natural teeth abutments.[4]

In osseointegrated implants, no fibrous capsule was found. The interfacial layer at the titanium- bone interface is rich in noncollagenous proteins as well as certain plasma proteins. The plasticity and biological remodeling possessed by the natural tooth is lacking in osseointegrated implants as they exhibit a rigid bone-implant interface, and this is responsible for decreased amount of mobility under functional loading and the transfer of excessive stresses to the surrounding bone that results in marginal bone resorption.[4]

On the other hand, PDL integrated dental implants help in formation of new cementum on the implant surface along with complete development of periodontal attachment that includes Sharpey's fibers and PDL fibers. This allows for bone remodeling and permits curative orthodontic movements of malpositioned dental implants.[4]

Advantages
It can decrease problems faced by implants such as gingival recession and bone defects of the missing tooth site. [1,3]
It mimics natural tooth.[1,3]
It induces bone formation.[1,3]
Despite the initial fitting being loose in order to spare PDL cell cushion, ligaplants firmly integrates without interlocking and without direct bone contact.[1,3]

Disadvantages
If proper caution (temperature, cells used for culturing, duration etc..) is not taken while culturing of ligaplants it may develop non periodontal cells which may lead to failure of ligaplant.[1,3]

Cost is high because of limited facilities and labour.[1,3] Host acceptance is unpredictable which may result in failure of implant.[1,3]

2. Discussion

According to Nyman S et al.,[1] the cells of periodontal ligament have the capacity to re-establish the connective tissue attachment to the teeth. There are some documented research study results available on PDL regeneration. Buser D et al.,[7] Warrer K et al.,[7] Takata T et al.,[7] Choi B H[7] demonstrated the cementum deposition and collagen fiber attachment to dental implants which are additional evidence for tissue regeneration. Parlar A et al.,[4] described an animal model in dogs for PDL generation and they revealed that newly formed periodontal ligament, alveolar bone, and root cementum filled the space between the implant and the wall of the root dentine chamber. Gault P et al.,[6] conducted a study where cells from PDL were isolated and cultured in bioreactor on titanium pins and then implanted in alveolus of dogs and humans and proved that ligament anchored implants have potential advantages over osseointegrated implants. Lin Y et al.,[2,7] proved that autologous dental progenitor cells(DPCs) derived from periodontal ligament (PDL), can be used to bioengineer PDL tissue on titanium implants in rats. Several in vivo experiments conducted proved the formation of cementum-like tissue with an intervening PDL when implants were placed in proximity to tooth roots. This phenomenon appeared to be due to migration of cementoblast and PDL fibroblast precursor cells towards implants due to contact of tooth related cell populations to those implants.[1] Rinaldiand A C et al.,[2] proved that periodontal ligament lay down cementum like layer on the titanium implant surface.

3. Conclusion

Dental implant treatment modality has become a worldwide demand, and the development of PDL attachment around implant has opened a new option to improve the biological performance of dental implants.[4] Most of the studies are carried out in animals and has revealed the success of ligaplants, still a feasible and predictable method for producing PDL attached implants has not been innovated and thus more human studies are required to know the success of these implants.[1] The advantages of ligaplants over conventional osseointegrated implants can make them the next advancement in the field of implant dentistry.[1]

References

[1] Bharathi D, Siji JT, Srinivasan, Senthil KS. Ligaplants-A review. Annals of dental speciality 2017; 5(2): 71-3.
[2] Nair ST, Sreedevi KG, Beevi R, Janam P. Ligaplants- a therapeutic modality on the horizon. JSPIK 2015; 8(3): 101-4.
[3] Kiong ALS, Arjunkumar R. Tissue-engineered ligament : Implant constructs for tooth replacement (Ligaplants). Journal of Pharmaceutical Sciences and Research.
[4] Moussa RM, Yassin HH, Saad MM, Nagy NB, Marei MK. Periodontal tissue engineering around dental implants. Stem cell biology and tissue engineering in dental sciences 2015, Elsevier publications, pp 765-74.
[5] Arunachalam LT, Sudhakar U, Merugu S, Janarthanan AS. Tissue-engineered periodontal ligament on implants : Hype or hope ? J Dent Implant 2012;2: 115-6.
[6] Gault P, Black A, Romette J-L, Fuente F, Schroeder K, Thillou F, Brune T, Berdal A,
[7] Wurtz T. Tissue-engineered ligament: implant constructs for tooth replacement. J Clin Periodontol 2010; 37: 750–8.
[8] Y. Lin, G.O. Gallucci, D. Buser,D. Bosshardt, U.C. Belser, P.C. Yelick. Bioengineered Periodontal tissue formed on titanium dental implants. J Dent Res 2011; 90(2):251-6.
[9] Warrer K, Karring T, Gotfredsen K. Periodontal ligament formation around different types of dental titanium implants.1. The self tapping screw type implant system. J Periodontol 1993; 64:29-34.
[10] Ripamonti U. Recapitulating development : A template for periodontal tissue engineering. Periodontal Tissue Engineering 2007; 13(1): 51-71.
[11] Rioz HF, Lin Z, Oh B, Park CH, Giannobile WV. Cell and gene based therapeutic strategies for periodontal regenerative medicine. J Periodontal 2011; 82: 1223-37.