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A New Innovation Of Implant: Ligaplant

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Abstract
Loss of soft and hard tissue are common problems leading to tooth loss. This crucial problem was solved by the introduction of an osseointegrated implant in dentistry to replace the missing natural tooth. With immense advancement in the field of regenerative medicine, these osseointegrated implants can be modified with combination of tissue cultured periodontal ligament cells to produce a hybrid known as Ligaplants (combination of titanium pins coated with hydroxyapatite and surrounded by tissue engineered PDL cells).

Keywords: Ligaplants , Periodontal ligament , Biohybrid implant , Tissue-engineering , Osseo- integration

Introduction

Periodontal ligament acts as a pillar between the tooth and underlying bone. Loss of supporting periodontal tissue in periodontal disease eventually lead to loss of tooth, which is the most concerning problem revolving in today's world.In order to cure this problem ,Branemark had introduced the concept of osseous integration by implant more than 50 years ago. However, they still lack a sense of proprioception due ankylosing .

Periodontal ligament cells derived from neural crest cells have the ability to produce collagen producing cells (Lim et al) . This ability of PDL cells of regeneration led to an innovative approach towards combination of titanium implant biomaterial and tissue engineered PDL cells known as "Ligaplants".[1]

New Generation Implant

Previously, the implants which were inserted into the jaw bones undergoes osseo-integration by ankylosing with the surrounding bone. However, they are various complications associated with these implants like lack of proprioception, gingival recession and bone loss surrounding the osseous integrated implant chances of peri-implantitis leading to failure of implants. These implants cannot be placed in bony defects.[2]

The revolutionary advances in the field of periodontal regeneration had paved a way to overcome these problems. The ability of Periodontal ligament cells to repopulate have given birth to the era of tissue engineering in periodontology.

"Ligaplants" are combination of titanium coated hydroxyapatite and tissue cultured periodontal ligament cells.These implants not only repopulate periodontal ligament cells but also have the ability to fill the bony defects .They restore the empty extraction socket with tooth which is similar to natural tooth exhibiting forces which are similar to that of natural tooth structure.[2]

Preparation Of Ligaplants

Preparation Of Temperature -Sensitive Culture Dishes:

N-isopropylacrylamide monomer in 2-propanol solution was spread onto polystyrene culture dishes.

Then the dishes were subjected to electron beam irradiation with an Area Beam Electron Processing System. The temperature-responsive polymer-grafted (poly N Isopropylacrylamide) dishes were rinsed with cold water to remove ungrafted monomer and sterilized with ethylene oxide

PDL Cells Culture:

The PDL cells are scraped from the extracted/avulsed tooth by scalpel 14 days prior to implant placement.This is followed by placement of this cells into culture dishes containing Dulbecco's modified Eagle's minimal essential medium which is supplemented with 10% fetal bovine serum and 100 units/mL of penicillin streptomycin. Then, the outgrowth cells were later on cultured in a humidified atmosphere of 5% CO_2 at 37°C for 48 hours so that the cells will get attached to the dishes.These dishes were washed so as to remove the remaining debris and the cultured medium will be changed 3 times per week.In order to obtain the harvest of the cell sheet, human periodontal ligament cells were plated on temperature- responsive culture dishes(35 mm in diameter) at a cell density of 1x107 and cultured at 37°C supplemented with 50mg/mL ascorbic acid 2-phosphate, 10nM dexamethasone and 10nM β-glycerophosphate that function as an osteo differentiation medium.

Preparation Using Bioreactor:

The Ti pins are coated with hydroxyapatite and placed in hollow cylindrical tube with gap of approximately 3 mm which acts as a cushion for growing of the PDL cells .This gap is slowly filled with the suspension of the tissue engineered cells cultured medium under the flow of growth medium for at least 18 days.3

Advantages Of Ligaplants Over Ossteo-Integrated Implants

1. Repopulate PDL cells providing sensory function.
2. Dissipate the excessive forces on the crestal bone.
3. Fill bony defects(Gault et al 2010) in the adjacent area of the implant to be placed. 4.Orthodontic tooth movements are possible.
4. When used as an implant supported denture, fabrication shows high success rates due to the similar resilience of periodontal tissues to that of normal periodontium.
5. Easy to place in the jaw as it does not require firm stabilization in contrast to ossteo-ingrated implants.
6. Can also be placed in regions with gingival recession areas as regeneration is possible.[1]

Limitations Of Ligaplants:

Inspite of many advantages of the ligaplants there are few things which have to be considered like

1. Prolong cell culturing might lead to no PDL cells repopulation.Hence the procedure of ligaplants preparation is quite technique sensitive .
2. High cost effective as the procedure requires a standard tissue culturing equipment and environment.
3. Last but not the least, the response of humans to these ligaplants are unpredictable as there are few clinical trials which can help to determine its sustainability in the jaws over a long period.[1]

Studies Done On Ligaplants [4]

Gault et al 2010[2] -had performed both in-vivo and invitro experimentation of ligaplants both on animal models as well as on humans. He found that not only there was formation of PDL fibers and but also restoration of bony defects in vicinity of ligaplants. However only few ligaplants were successful in human trials as the PDL phenotype was lost in failed ones. This was because the development of a regenerative PDL depends on site-specific signaling, which in turn is mediated by an anatomic code, written in expression patterns of homeogene-coded transcription factors, as was earlier postulated for the skeleton (Wurtz & Berdal 2003). According to Yoshizawa et al. 2004 homeobox gene Msx2 is the one which has been implicated in the segregation of mineralized bone against non-mineralized bone.

Rinaldiand Arana Chavez et al 2010[6] had performed an experiment on animal models by placing titanium mini-implants and found that the interaction between titanium and PDL cells lays down a cementum like layer.

Lin et al 2011[7] had placed autologous PDL progenitor cells along with implants in rat model and suggested that there is potential for PDL regeneration when bioengineered PDL cells placed in conjunction with implant biomaterial.

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Kano et al 2012[8] had placed immediate implants coated with hydroxyapatite(HA) and observed PDL regeneration on these implants.

Conclusion

The consistent rise in the field of regenerative medicine have made it possible for rebirth of the periodontal ligament in previously lost tooth.This revolutionary research of perio-dontio integrated implant have made a foothold in the field of regenerative periodontal where the hybrid of tissue cultured PDL cells and implant can be placed together.[1]

Though technique sensitive procedure , once put together will dispel many problems related to ankylosed osseointegrated implants and also pave the way for future implantologists .

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