

Ligaplants: Periodontio – Integrated Implants

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Abstract- With regenerative dentistry becoming the new trend, tissue engineering has undergone significant advancement .development of periodontal ligament attachment around implants is now being taken into consideration to replace the lost teeth with functional stability by embarking the formation of periodontal ligament and cementum formation . hence , periodontal ligament houses various cells that are all important in improving the biological performance and to prolong the life of the prosthesis.

Keywords- implant, periodontal ligament, regeneration, bioengineering

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I. Introduction

Periodontitis is a multifactorial disease which leads to changes in the tooth supporting structure and involves 80% of adults amongst which 50% face early tooth loss.¹ The periodontal therapy ends to regenerate the lost structure specially in cases of severe destruction where the attachment of the tooth has compromised. ² New attachment can be achieved by the regeneration of the periodontal ligament fibres and the insertion of the same on the root surface. ³ This concept of periodontal ligament regeneration is being carried out on the surface of dental implants in order to replace the lost teeth. Periodontal ligament has regenerative capacity and hence implant with periodontal ligament called as ‘ligaplant’ is the new emerging era in the field of dentistry where tissue engineered periodontal ligament cells on the implant surface are formed thus mimicking the natural tooth. Dental implant osseointegrates with the living bone by functional ankylosis without any periodontal ligament support. But during peri-implantitis there is more severe bone loss as compared to that in periodontitis. Hence implant dentistry has focused on the preservation of the soft tissue.

II. Tissue Engineering

In the field of dental implants tissue engineering is a new innovative technique in bone grafting⁴. This was proposed by Langer and colleagues in 1993⁵ for the regeneration and restoration of the lost tissue . By this process we can reconstruct the natural tissue. The important elements required in this reconstruction procedure is-

- i) matrix or a scaffold
- ii) signalling molecules
- iii) cells

This can be done by both in vitro and in vivo.

In vitro technique is the tissue is prepared in the laboratory. The cells are cultured on the biodegradable scaffolds or matrix with the help of signalling molecules following which they are transplanted into the body. Whereas ,in vivo technique all the three vital elements are placed in the tissue defect which later undergoes natural healing process in the body giving rises to regeneration.⁶

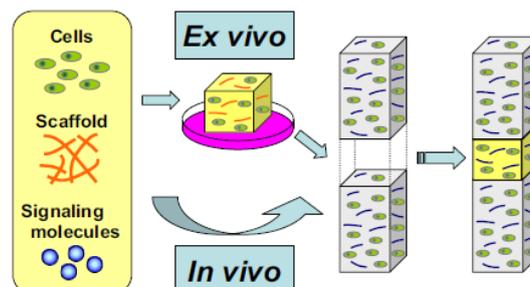


Fig 1: Ex vivo technique- to create tissue or organs in culture room by the combination of three elements (scaffold or matrix, signaling molecules, and cells) before transplanting tissue-engineered organ into patients. In vivo technique- induces intrinsic healing activity at site of tissue defect using the three elements.

Second technique is to induce intrinsic healing activity at site of tissue defect using these three elements (in vivo approach).

In 1990, Buser et al. conducted a study which he found that the periodontal ligament cells could be a source of regeneration as they have the ability to cover the surface of dental implants during healing period.⁷

Interphase Of Implant And Periodontal Ligament-

The fibroblasts of the periodontal ligament have the ability to proliferate and differentiate into the cementoblasts, thereby forming a mineralised connective tissue called the cementum.⁸ Also, bone along with the alveolus surrounding the ligaplast site was seen to form suggesting osteogenic potential of the periodontal ligament fibres.⁷ The presence of periodontal ligament fibres around the tooth have significant role in the transmission of the masticatory forces to the surrounding bone. But in case of dental implants, due to the absence of periodontal ligament fibres, this force is not dissipated equally and effectively as in case of natural teeth.⁹ Hence by tissue engineering process we can create an environment around the implant similar to that of the natural teeth.

The gene cells and protein therapy helps in ligament neogenesis and covers the implant surface,⁸ thereby giving rise to a new concept of oral implantology.

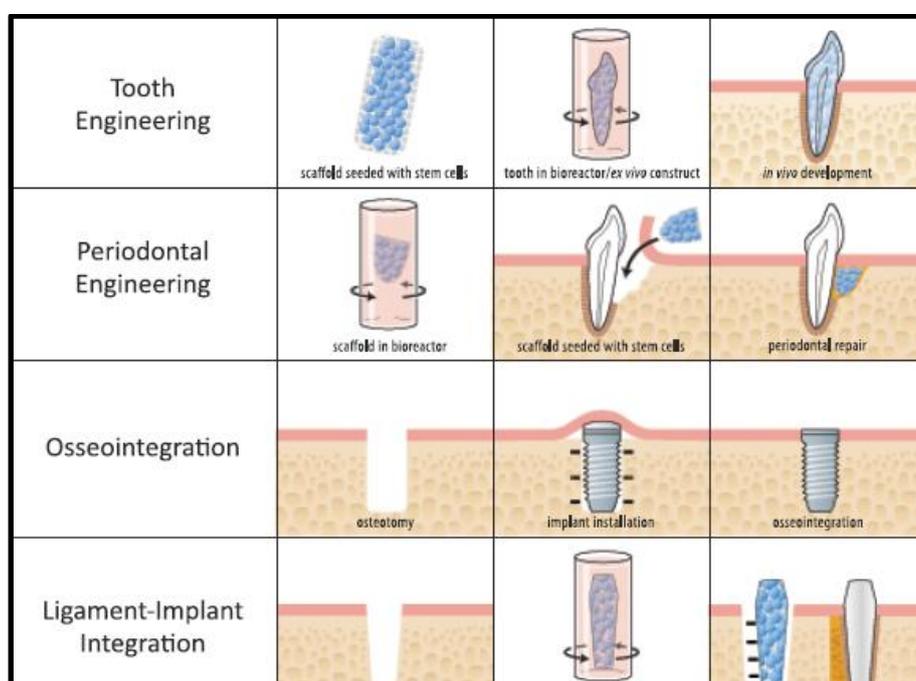


Fig 2 : Stem cell-based therapies used in the bioengineering of teeth, periodontium and alveolar bone structures.

Preparation Of Ligaplast-

- 1) Polystyrene culture dishes containing N- isopropyl acylamide monomer and 2 propanolol solution are exposed to Area Beam Electron Processing System (ABEPS). Then the ungrafted monomer are removed by rinsing culture plates with cold water and ethylene oxide is used to sterilize them.
- 2) Periodontal ligament cells were scraped of using a scalpel from the middle third of an extracted tooth. These cells were inoculated in culture dishes containing Dulbecco's Modified Eagle's Minimal Essential Medium supplemented with 100 units/ ml of penicillin, streptomycin and 10% fetal bovine.⁹
- 3) These cells are cultured in an environment of 5% CO₂ at 37°C for 48 hours so that the cells get attached to the dishes. The debris are washed off and the medium is changed three times a week.
- 4) Harvesting of the periodontal ligament cells sheet is done on temperature responsive culture dishes at 37°C and a cell density of 1x10⁵.
- 5) A hydroxyapatite coated titanium pin is placed in a hollow plastic cylinder having a 3 mm space around the pin. Plastic vessels are seeded with periodontal ligament cell suspension for 18 days under a flow of growth medium.

Precautions While Preparing Ligaplant-

- 1) Proper sterilization must be maintained throughout the procedure. ¹¹
- 2) Proper culturing and cell growth is necessary, otherwise it may to the formation of non- periodontal ligament cell types.
- 3) Micromechanical movements of the growth medium is necessary for firm attachment of the cells to the implant.
- 4) Adequate duration of surface treatment must be maintained for the success of the ligaplant.

ADVANTAGES-

- 1) Ligaplants mimic the anatomy of a natural teeth (having periodontal ligament around it along with the alveolar process).
- 2) Amount of bone loss in peri-implantiis is reduced.
- 3) It resolves the problems of intrabony defects around the missing teeth.
- 4) Osseointegration was found around the implant surface, thereby depicting a firm communication between the two.
- 5) Initially after the placement of the ligaplant, it has a loose fitting so as to allow the formation of periodontal ligament around the implant surface.

But later on bone formation is induced and it attains firmness inspite of the absence of the direct bone contact. ¹²

Disadvantages-

- 1) Highly technique sensitive procedure.
- 2) Host acceptance of the implant is unpredictable.
- 3) Costly procedure.
- 4) Proper maintenance of temperature, duration of culture etc. makes it a complicated procedure.

Review of literature-

- 1) Gomez Flares M et al (2008) ² conducted a study to find out if a multi layered hum responsive periodontal ligament cell sheet could be used for periodontal regeneration and concluded that this strategy could be used as a new strategy to reconstruct the periodontal ligament-cementum complex.
- 2) Buser D et al (1990) ¹³ conducted an experimental study in monkeys to examine the wound healing in dental titanium implants which was placed in place of retained root tips (as they would serve as a source of cells for regeneration). Their results state that these implants had periodontal ligament formation on their surface along with a cementum layer.
- 3) Gulati et al (2012) ¹⁴ reported a scientific evidence of periodontio-integrated implants using online publications from Pubmed, wiley, Blackwell, Elsevier etc between 1980-2012 and reported that there were many successful studies on ligaplants in the past three decades and hence concluded that periodontally supported implants are a revolutionary approach for both periodontists and oral implantologists.
- 4) Y Lin et al (2011) used dental progenitor cells to form periodontal ligament cells on dental implants in maxilla of rat and the analysis revealed the presence of periodontal ligament on the surface of dental implant.hence they concluded that periodontal ligament DPcs have the ability to reorganise the periodontium in the site of missing teeth .
- 5) Gault p et al (2010)describedtheclinical application of periodontal ligament cells cultured on the surface of the titanium pins and placement of the latter in the alveolar process. There was integration of the titanium pins with the alveolar bone along with the new bone formation in the vicinity .

III. Conclusion

Implants have become a new advancement in dentistry ,andperiodontal ligament tissue engineering around dental implants have taken implant dentistry to get another level. Ligaplants give a better long term stability by stimulating the optimal functioning of a normal human teeth with less inconvenience and discomfort .

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