

Ligaplants - A novel concept for implant placement

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Citation of this Article: Dr. Nilima Rajhans, Dr. Pradnya Ashok Morey, Dr. Nilima Daule, Dr. Asawari Lawande, Dr. Shaikh Afreen Nooruddin, “Ligaplants - A novel concept for implant placement”, IJDSIR- December - 2022, Vol. – 5, Issue - 6, P. No. 44 – 47.

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Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Liga plant is the new emerging era in the field of dentistry where the combination of Periodontal ligament cells with implant biomaterial is being clinically tried.

Because Osseo integrated implants are ankylosed and do not have the same mobility as natural teeth, new treatment modalities like Ligaplants are being tried to compensate for this obvious difference by a shock-absorbing system built into the implant or its superstructure.

Liga plants become firmly integrated without inter locking direct bone contact and also alleviates problems

like gingival recession and bone defects of a missing tooth.

Periodontal ligament cells have regenerative capacity. In Liga plants, tissue-engineered periodontal ligament cells are grown on the implant surface, thus mimicking the natural tooth roots in the alveolar process. Consequently, bone formation is also induced. This combination of PDL cells with implant biomaterials results in a shock-absorbing system built into the implant unit.

The aim of this review paper is to provide information regarding Ligaplants as it is now an advanced option to improve the biological performance and to prolong the life of the implant unit.

Keywords: Dental implants, Periodontal ligament, Tissue engineering, regeneration

Introduction

Nowadays in the field of dentistry, fixed and removable partial dentures are being replaced by implants, which are considered ideal to replace missing teeth. For successful implant placement, adequate jaw bone width and height, patient health, the type of implant selected and dental surgeon expertise are very important.¹ Never the less, problems still exist with dental implants because they lack periodontal ligament (PDL) attachment.

Due to the lack of periodontal ligament (PDL), inflammation around the dental implant may cause serious bone loss, than the inflammation around the natural tooth with the periodontal ligament. This richly vascular, soft, and cellular connective tissue permits forces, produced during masticatory function, and other contact movements to be distributed to the alveolar process through the alveolar bone proper. It acts as a shock absorber, giving the tooth some movement in the socket. It also gives proprioception. In contrast, dental implants do not have mobility like natural tooth as they are ankylosed with the supporting jaw bone. The PDL also play an important interaction with adjacent bone by playing the major role of periosteum at the bone side facing the root. it also accommodates vital cells such as osteoclasts, osteoblasts, cement oblasts, cement clasts, fibroblasts, and most importantly the undifferentiated mesenchymal stem cells. These cells are important in maintaining the dynamic relationship between the tooth and bone.²

Busser et al in 1990³ showed that the dental implant made of titanium when placed in contact with retained root tips, the PDL of these roots served as a source for cells which could cover the implant surface during

healing. So, nowadays tissue engineering has given a new prospect in periodontal regeneration and in the treatment of dental implants.

Till now, Osseo integrated implants due to their long-term clinical survival rate are considered to be the most acceptable implants but these problems could only be resolved if an implant with PDL could be developed. This can be achieved by new generation tissue-engineered Ligaplants which is nothing but the combination of implant biomaterial with PDL cells.

Ethical Application

Ligaplants are considered to be a new treatment modality, which are being tried clinically in vivo and in vitro. They have shown good results in animal studies as well. Although in vivo results are yet to be correlated. Many successful experiments have been carried out to construct “implant supported by the periodontium” which can maintain form, function and potential proprioceptive response similar to natural tooth. The possibility of the future clinical use of such implant can be strongly stated based on these strong evidences, which would revolutionize the implant dentistry and also favoured by the patient.

Properties of Ligaplants

1. It acts as a shock absorber which gives the tooth some movement in the socket.
2. It helps in providing proprioception
3. PDL has an important role in interaction with the adjacent bone, plays a role of periodontium at the bone side facing the root.
4. It contains vital cells such as osteoclasts, osteoblasts, cement oblasts, cement clasts, fibroblasts and most importantly the undifferentiated mesenchymal stem cells.
5. These cells are important in maintaining the dynamic relationship between the tooth and bone.

Procedure for making Ligaplants

One of best method for preparation of Ligaplants is tooth transplantation with double PDL stimulation. The donor tooth extracted and replanted immediately in its original alveolus, 14 days before transplantation.

Cells proliferation and differentiation takes place due to the deliberate trauma which triggers a healing process within the PDL. The transplantation of the tooth can be carried out with millions of cells attached to its root by new sharpey's fibers after 14 days⁴, when the in vivo cell culture reaches at its peak of activity.

Preparation of temperature-responsive culture dishes

The polystyrene culture dishes are taken and N-isopropylacrylamide monomer in 2-propanalol solution is spread onto them. Then, the dishes are subjected to electron beam irradiation by using an area beam electron processing system.

The temperature-responsive polymer-grafted (poly n-isopropylacrylamide) dishes are rinsed with cold water to remove ungrafted monomer. Then the dishes are sterilized with ethylene oxide.⁵

Cell and cell culture

The human PDL cells are isolated by scraping the periodontal tissue from middle third of the root of extracted tooth with a scalpel blade. Then the harvested tissue was placed into culture dishes which contain 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 are cultured in a humidified atmosphere of 5% CO₂ for 48 h at 37°C to allow attachment of cells to the dishes. The dishes are then washed to remove the debris. The medium is changed three times per week.

Cell sheet is harvested by plating the human PDL cells on temperature responsive culture dishes at a cell density of 1×10^5 which is then cultured at 37° c.

later, 50 mg/mL ascorbic acid 2-phosphate, 10 nM dexamethasone, and 10 nM β -glycerophosphate are added into the culture dishes that function as an osteo differentiation medium.⁶

Culture of pdl cells in a bioreactor

A hydroxyapatite coated titanium pin is placed in a hollow plastic cylinder. Gap of 3mm is left around the pin. The culture medium is pumped through the gap continuously. The single cells suspension obtained from human are first seeded into plastic vessels under a flow of growth medium for 18 days.⁵

Risk factors of Ligaplants

Site signalling is the major factor for development of PDL and is largely mediated by anatomic code and home gene-coded transcription factors.

These homeoproteins are very important for synthesis of cell surface and signalling components. The factors affecting the growth of PDL at the desired site are unpredictable, therefore it becomes the major risk factor for the treatment results to be obtained.

Advantages of Ligaplants

1. It reduces problems like gingival recession and bone defect of newly placed implant.
2. Ligaplants simulates the natural insertion of natural tooth roots in alveolar bone.
3. Ligaplants get firmly integrated without interlocking and without direct bone contact, in spite the initial fitting being loose for sparing PDL cell cushion.⁷

Disadvantages of Ligaplants

1. Caution should be taken while culturing the Ligaplants. i.e., the temperature and duration of culturing, the cells that are used for culturing, and others. If during culturing some problem occurs, then the nonperiodontal cells may develop, which may lead to the failure of Ligaplants.
2. The cost of such an implant is high due to limited

facilities and members to perform this procedure.

3. The prolonged culturing can cause the growth of non PDL type cells.⁴

4. The growth of PDL in the socket as well as factors affecting the host to accept the implant are unpredictable, this may lead to the failure of the implant.²

The success of Ligaplants

Regenerative PDL development depends on site-specific signalling, which is mediated by an anatomic code which is written in expression patterns of home gene-coded transcription factors. Homeoproteins influence the synthesis of cell surface and signalling components. Home gene expression is modulated by signals from cell surface feedback. The cell identities are established according to anatomic site and tissue type.⁸

Conclusion

As new technologies are coming in the field of dentistry, more research findings and testing can achieve a successful future for Liga plant that will lead to its long-term stability, function, and survival.

The studies carried out in animals have showed that periodontal tissue generation around the implant is possible, hence further research on humans with long-term follow-up can bring feasibility and success to Ligaplants which will open up new possibilities for a periodontist.

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