

LIGAPLANTS – A REVIEW

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Abstract

Periodontitis is the disease causing the destruction of the soft and hard tissues surrounding the tooth. If left untreated, periodontal destruction may progress and lead to mobility and ultimately loss of teeth. Replacement of the missing tooth with implant has gained popularity among the population. The advent of periodontal tissue engineering has revolutionized not only periodontology but also implant dentistry at large. This review article highlights the tissue engineered periodontal ligament on implants, which is going to change the traditional way of implant treatment.

Key words: Periodontal ligament, tissue engineering, tooth implant.

Introduction

Nowadays, fixed and removable partial dentures are replaced by implants, which holds ideal for replacing missing tooth. For implant to be successful factor such as sufficient bone [height and width] is very crucial. Before placement of the implant, local bone defects and generally poor bone quality necessitate bone reconstruction¹. Besides that, localized bone loss around the implant fixture represents the clinical challenge², especially in the case of gingival recession, which requires further surgical interventions.³ However, problems still exist with these implants as they lack PDL, because any inflammation around them may cause serious bone loss than does the inflammation around the natural tooth with PDL. In addition, these implants are ankylosed and do not have the same mobility as the natural teeth.⁴ Currently, Osse-integrated implants are generally agreed to be the most acceptable implants because of their high long term clinical survival rate. These problems could be resolved, if implant with PDL could be developed this is achieved by LIGAPLANTS, which is nothing but combination of the PDL cells with implant biomaterial. [Figure-1]

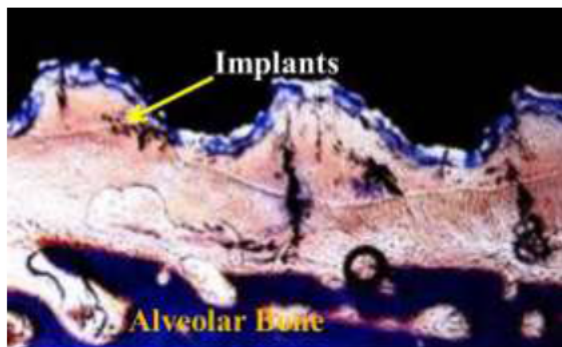


Figure 1: Ligaplants

Properties of Ligaplants

1. PDL cells act as a soft, richly vascular, and cellular connective tissue which permits forces elicited during masticatory function and other contact movements to be distributed to the alveolar process via alveolar bone proper [Figure-2].
2. It act as a, shock absorber giving the tooth some movement in the socket.

3. It provides Proprioception.
4. Periodontal ligament homes vital cells like osteoclast, osteoblast, fibroblast, cementoclast, cementoblast and most importantly undifferentiated stem cells which are osteoconductive in nature.⁷
5. 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.⁶

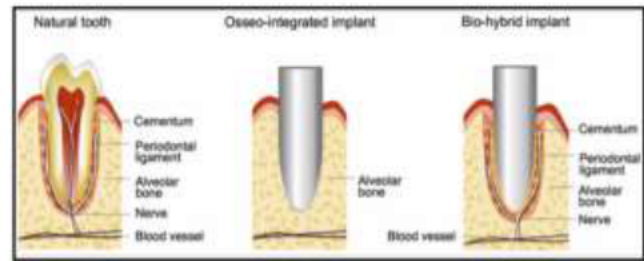


Figure 2: Comparison between natural teeth, osse-integrated implant and ligaplants

Advantages

1. It Alleviate problems like gingival recession and bone defects of missing tooth.
2. Mimics natural insertion of natural tooth roots in alveolar process.
3. Ligaplants become firmly integrated without interlocking and without direct bone contact, despite the initial fitting being loose in order to spare PDL cell cushion.⁷
4. Bone formation was induced and movements of ligaplants inside the bone suggesting an intact communication between bone and implant surface.⁵

Disadvantages

1. The culturing of ligaplants should be done with caution (i.e) the temperature, the cells that are used for culturing, the duration of the culturing and others. If some problem evokes during the culturing, the ligaplants may fail as other non-periodontal cells may develop.

2. Besides that, with limited facilities and members to perform this research, the cost of this type of implant is high.
3. The factors affecting the host to accept the implant or the growth of PDL in the socket is unpredictable, which may result in failure of implant.

Procedure of Obtaining Ligaplasts

Tooth transplantation with double PDL stimulation is one of the best examples of its healing capacity. Fourteen days before transplantation, the donor tooth is extracted and immediately replanted in its original alveolus. This deliberate trauma triggers a healing process within the PDL, which includes cell proliferation and differentiation. The in vivo cell culture reaches its peak of activity after 14 days, after which the transplantation of the tooth can be performed with millions of cells full activity attached to its root by new Sharpey's fibres.^{3,5,9}

Using this model in its biological and clinical aspect, we now use similar cell culture around an artificial root using tissue engineering techniques.

Preparation of temperature-responsive 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.⁵

Cells and cell culture

Human periodontal ligament cells were isolated from an extracted tooth. After extraction, periodontal tissue was scraped from the middle third of the root with a scalpel blade. The harvested tissue was placed into culture dishes containing = Dulbecco's modified Eagle's minimal essential medium, supplemented with 10% fetal bovine serum and 100units/mL of penicillin-streptomycin. Then, those outgrowth cells were cultured in a humidified atmosphere of 5% CO₂ at 37°C for 48 hours to allow attachment of the cells to the dishes. The dishes were washed to eliminate debris and the medium was changed three times per week. To harvest the cell sheet, human periodontal ligament cells were plated on temperature-responsive culture dishes (35 mm in diameter) at a cell density of 1x10⁵ and cultured at 37°C supplemented with 50mg/mL ascorbic acid 2-phosphate, 10nM dexamethasone and 10nM β-glycerophosphate that function as an osteodifferentiation medium.^{5,10}

Culture of PDL cells in a bioreactor

A titanium pin, which coated with hydroxyapatite (HAP), was placed in a hollow plastic cylinder leaving a gap of 3mm around the pin. Culture medium was continuously pumped through the gap. Single cells suspension, obtained

from human, was seeded first into plastic vessels under a flow of growth medium for 18 days.^{5,10} [Figure-3]

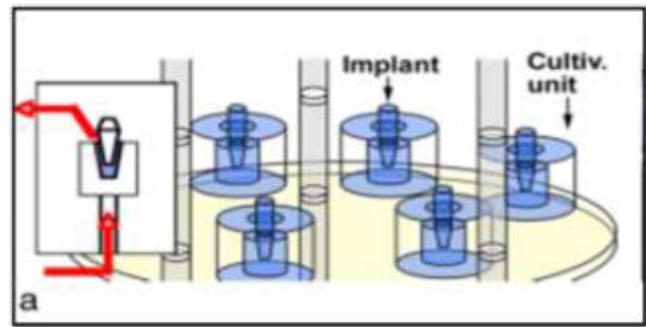


Figure 3: Bioreactor

Precautions when preparing ligaplasts

A cushion of sufficient thickness favours the formation of PDL and on the other, the prolonged cell culturing may favour the appearance of non-PDL cell types. In order to preserve the cell differentiation state and to obtain adequate cell stimulation, the bioreactor has been constructed with the aim to resemble the PDL situation during cell growth; cells are positioned in a narrow space between the ligaplast and surrounding hollow cylinder. It was thereby anticipated that the PDL phenotype would be favoured implicating a tight attachment of cells to the implant. So, the preparation of the ligaplasts should have minute mechanical movements of the medium flow and space between the implants and the culture should be optimal and the duration of the surface treatment should also be optimal to obtain the successful ligaplasts which brings big improvements to the implant system.⁵

Evidence based studies on ligaplasts

Nyman *et al.* 1982¹⁷ suggested that the cells of the periodontal ligament possess the ability to reestablish connective tissue attachment. Nunez *et al* 2012 further validated the regenerative potential of periodontal ligament-derived cells in a proof of principle study. Several in vivo experiments have demonstrated the formation of cementum-like tissue with an intervening periodontal ligament, when the dental implants were placed in proximity to tooth roots. Mechanism of this phenomenon appeared to be due to migration of cementoblast and PDL fibroblast precursor cells towards dental implants due to contact or proximity of the tooth-related cell populations to those implants.

Conclusion

Most of these studies are carried out in animals and has been revealed that generating a periodontal-like tissue around implants is possible, still a predictable and feasible method for producing dental implants with periodontal-like ligament has not been innovated and more studies are required in clinicals especially in humans in order to know its long term stability, function, survival and success of these implants.

Ligaplasts as teeth replacement seems to have decisive advantages as compared with osseointegrated implant, due to their periodontal tissue regeneration and can be the next advancement in the field of implant dentistry.

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