

Ligaplants a Natural Implant Hype or a Hope : A Review

Dr. P. Aravind Kumar

Professor, Department of Periodontics
St. Joseph Dental College and Hospital
Eluru, West Godavari District, Andhra Pradesh, India

Dr. Tejaswi Kodem

PG Student, Department of Periodontics
St. Joseph Dental College and Hospital
Eluru, West Godavari District, Andhra Pradesh, India

Abstract:- Periodontitis is the disease that causes destruction of the soft and hard tissues around the tooth structure. Without treatment, periodontal destruction may lead to mobility and ultimately leading towards loss of tooth. Substitution of the lost tooth with implant has acquired popularity among the people. The emergence of periodontal tissue engineering has transformed implant dentistry along with periodontology. Ligaplants highlights the aspect of tissue engineered periodontal ligament cells on implants, which will in turn change the conventional way of treatment by implants. The PDL fibers are the prime structures involving in tooth anchoring, it thereby inter links tooth root and alveolar bone proper, and it assists in bone formation. Tissue-engineered periodontal ligament (PDL) surrounding the dental implants would constitute to a chief modern therapeutic tool to restore lost teeth.

Keywords:- Ligaplant , missing tooth, tissue engineering, periodontal ligament, periodontitis.

I. INTRODUCTION

Periodontitis can be defined as chronic inflammatory disease of supporting tissues of tooth structure caused by certain microorganisms or a bunch of specific microorganisms, leading to progressive destruction of the periodontal ligament and alveolar bone along with periodontal pocket formation, gingival recession [1].

Historically periodontal diseases and caries have been observed as the major oral health burdens. Recently showing an accelerated trend of tooth loss from periodontitis than dental caries; the presence of clinical attachment loss, bone loss and the habit of smoking enhances the chance of tooth loss [2].

II. WHAT IS A DENTAL IMPLANT

Dental implant is a structure which replaces the lost tooth, appearing as titanium made screw. It copies the tooth root function. A major development in dentistry is the rise in substitution of lost natural dentition by osseointegrated dental implants and the recent and future utility of implants as supporting intra- and extra-oral prostheses is a great inference in replenishing dental health [2]. Osseointegrated implants are the most acceptable implants due to their survival rate which is long term[3,4].

III. INDICATIONS / CONTRAINDICATIONS OF IMPLANTS

A. Indications

- Patient without any teeth.
- Oral abnormalities in patients.
- Missing teeth.

B. Contraindications

- Systemic disease such as uncontrolled diabetes including pathological disorders.
- Smoking and tobacco chewers.
- Immunocompromised patients.
- Lack of good oral maintenance.
- Stress and Psychological related problems.
- Trauma from occlusion.

Pathologically formed disorders of the alveolar bone and xerostomia [2].

Fixed removable partial dentures are nowadays mostly replaced by implants, which are considered to be ideal for replacing missing tooth. Bone loss around the implant is localized this poses a clinical challenge[1,2,3]

Problem is still present with these types of implants because of the lack of periodontal ligaments³. Pdl apart from tooth anchorage dispenses progenitor cells for the formation of alveolar bone and remodeling. Periodontal disease along with tissue breakdown and inflammation causes resorption and alveolar bone loss. Problems can be evaded, if there could be a development of a implant with surrounding periodontal ligament. This is achieved by ligaplants; it is nothing but a combination of implant biomaterial along with pdl cell[3].

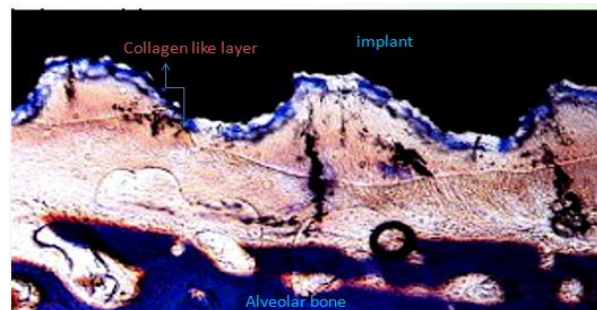


Fig 1:- implant and alveolar bone interface

➤ *Procedure for obtaining ligaplant*

Double pdl stimulation is done by the help of tooth transplantation which increases the healing capacity. Prior to transplantation, the donor tooth extraction is done before 14days and this tooth is planted immediately into the alveolus. The trauma is induced deliberately which activates a physiological healing process in the periodontal ligament, enhancing the cells to proliferate and to differentiate. The present in vivo cell cultures peak is reached after 14days [8,10,13].

➤ *Temperature responsive culture dishes preparation*

Polystyrene culture dishes were taken N-isopropylacrylamide monomer along with 2-propanol solution was unrolled on to these culture dishes. These dishes were exposed to electron beam irradiation with area beam electron processing system. Cold water is used to rinse the Temperature responsive polymer-graft dishes which help in removal of engrafted monomer, ethylene oxide is used for sterilization [10].

➤ *Obtaining the cell and culturing of the cell*

The cell (human periodontal ligament) is obtained from an extracted tooth. A scalpel blade is used to scrape of the periodontal tissue, which is obtained from the middle third portion of the root. Culture dishes prepared containing Dulbecco's modified eagle's minimal essential medium, supplemented with 10% fetal bovine serum and 100units/ml of penicillin-streptomycin. The harvested tissue is paced in the culture dishes.

The out grown cells are cultured in a humidified atmosphere of 5%CO₂ at 37°C supplemented with 50mr/ml ascorbic acid 2-phosphate ,10nm dexamethasone and 10nM β-glycerophosphate, all these form a substances which function as osteodifferentiation medium [10,14]

➤ *Bioreactor: pdl cell culturing*

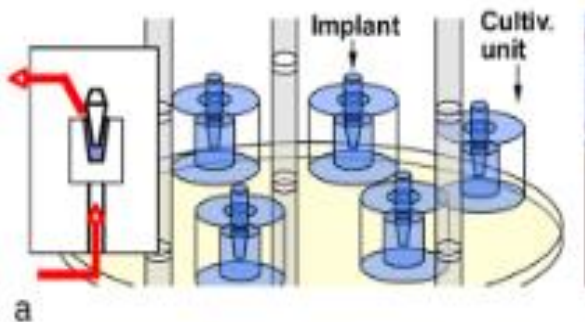


Fig 2:- Bioreactor: pdl cell culturing

Hollow plastic cylinder is taken inside which are titanium pins they are coated by hydroxyapatite (HAP) and are positioned at a gap of about 3 mm is left around the pin. Continuous pumping of the culture medium is done through the gap. The cell suspension, which is derived from human, is

seeded primarily into the plastic vessel then on the titanium pins under the flow of the growth medium for a time period of 18 days [10, 14].

➤ *Preventive measures to be taken in ligaplants preparation*

Prolonged cell culturing leads to development of non-pdl cells, formation of pdl is achieved by a sufficient thickness of cushion. The construction of the bioreactor is done in such a way to recreate the pdl stimulation during growth phase of the cell to conserve the cell differentiation state and to gain required stimulation. Space present between the ligaplants and the hollow cylinder is occupied with cells, this preparation while processing for a ligaplant should have small mechanical movements by which the medium flows. A successful implant can be obtained by following some of the principals such as maintaining a optimal space between the implant and the culture, even the duration of surface treatment is taken into consideration which will eventually lead to a huge progress to the implant system [3,10].

➤ *Studies on ligaplants: evidence based*

Nyman et al 1982 connective tissue attachment is reestablished by the cells of the periodontal ligament . Nunez et al 2012 the proof of the principal study is the regenerative potential of the periodontal ligament cells was further validated by nunez [19].

In vivo studies have been done extensively in this field showing the formation of cementum like tissues with periodontal ligament intervening, this is seen when the dental implants are in close vicinity to the tooth roots [3,18].

IV. REGENERATIVE CAPACITY OF PERIODONTAL LIGAMENT

The explicit clinical results gained from the repair approach have enhanced the efforts to regain regeneration of the primary periodontal attachment. Numbers of investigators have notified the regeneration of the PDL and the aspect of newly formed calcified tissue on dentin and cementum during the healing phase of the experimental periodontal wounds. It has been presumed that PDL cells are accountable for this new cementum and PDL regeneration. But the epithelial cells, gingival connective tissue cells, and bone cells must be prevented from occupying the wound area in the initial phase of healing. The rate of proliferative of epithelia is more than the PDL cells, and the alveolar bone defect is fully covered by the more numerous gingival connective tissue and alveolar bone cells [19].

The main mechanism in this process is the migration of pdl fibroblast and cementoblats towards the implant due to its close vicinity, hence cell population occurs on the implant surface [3, 20]. The surgical procedures of ligaplant is said to be easy by Gault et al [10]

Fresh periodontal ligament attachment is formed on titanium dental implants when they are placed along with cultured periodontal ligament cells. Due to the lack of

periodontal ligament, any inflammation around them will cause drastic bone loss than with inflammation around teeth with a periodontal ligament. In addition, these implants have been ankylosed and possess no amount of mobility equal to natural teeth with a periodontal ligament. To compensate for this difference, in one system a mobile element has been designed for placement in the implant or its superstructure [17].

➤ *Ligaplant and its properties*

- Force dissipation: these pdl cells which are richly vascular and soft which allow forces produced during mastication and many contact movements to be carefully spread to alveolar process.
- It acts as shock absorber.
- Proprioception is provided.
- Many osteoconductive cells are a part of pdl such as: undifferentiated stem cells, cementoblasts, cementoclasts, fibroblasts, osteoclasts, and osteoblast.

➤ *Ligaplant: Advantages*

- Problems like soft tissue recession and alveolar bone defects of missing tooth are diminished.
- It resembles Natural tooth insertion.
- Firm integration of the ligaplant is seen without the interlocking or any direct bone contact, even though the initial fit is unattached to spare pdl cell cushion.
- A complete link is established between the alveolar bone and the dental implant surface is suggested by movements of ligaplant inside the bone.

➤ *Ligaplant: Disadvantages*

- Culture sensitivity: the temperature, culturing cells used, culturing time, others. Any problem in these leads to a failed ligaplant
- Limitations :
 - limited members to do this kind of research
 - limited facilities
 - cost factor is more
- There is certain unpredictability on how the host accepts the ligaplant and pdl cell growth inside the socket, this leads to failure of the ligaplant.

V. CONCLUSION

It can be said forth that periodontal ligament-like tissue attachment may form surrounding dental implants when it is placed along with cultured periodontal ligament cells. Application of cultured periodontal ligament cells onto the surface of the implant may open a new perspective in implant dentistry.

The ligaplant placement is comparatively easy as the implant is not tightly fit. On the other hand the patient may not have the need to undergo any further discomfort of grafting with ligaplants [20].

Mostly these studies are carried out on animals, these studies revealed that pdl layer around the implant is possible, yet a proper method to produce such a implant with a accurate method has not been developed, more studies are essential especially in humans to understand the ligapants and their durability.

REFERENCES

1. Newman MG. Classification and epidemiology of periodontal diseases. Carraza's Clinical Periodontology, 10th ed. Philadelphia: WB Saunders Company; 2007. p. 100-29.
2. Rajiv Saini .Research and Reviews: Journal of Dental Science Dental Implants: A Review. 2013.
3. Bharathi D, Siji Jacob , Srinivasan, Senthil Kumar S:ligaplants –a review.
4. Sennerby L, Rocci A, Becker W, Jonsson L, Johansson LÅ, Albrektsson T. Short-term clinical results of Nobel Direct implants: a retrospective multicentre analysis. Clin Oral Implants Res 2008;19(3):219-26.
5. Byung-Ho Choi Department of Oral and Maxillofacial Surgery, Periodontal Ligament Formation Around Titanium Implants Using Cultured Periodontal Ligament Cells: A Pilot Study 2000.
6. Sennerby L, Rocci A, Becker W, Jonsson L, Johansson LÅ, Albrektsson T. Short-term clinical results of Nobel Direct implants: a retrospective multicentre analysis.Clin Oral Implants Res 2008;19(3):219-26.
7. Ekfeldt A, Eriksson A, Johansson LÅ. Peri-implant mucosal level in patients treated with implantsupported fixed prostheses: a 1-year follow-up study. Int JProsthodont 2003; 16 (5)529-532.
8. Gault PC, Warocquier-Clerout R. Tooth autotransplantation with double periodontal ligament stimulation to replace periodontally compromised teeth. J Periodontol 2002;73 (5):575-83.
9. Schou S, Holmstrup P, Stoltze K, Hjørting-hansen E, Kornman KS. Ligature-induced marginal inflammation around osseointegrated implants and ankylosed teeth. Clinical and radiographic observations in cynomolgus monkeys (Macaca fascicularis). Clinical Oral Implants Res 1993;4 (1):12-22.
10. Gault P, Black A, Romette JL,Fuente F, Schroeder K, Thillou F, et al. Tissue-engineered ligament: implant constructs for tooth replacement. J Clin Periodontol 2010;37(8):750-8.
11. Kiong AL, Arjunkumar R. Tissue-engineered Ligament: Implant constructs for Tooth Replacement (Ligaplants). J Pharm Sci Res 2014;6(3):158-160.
12. Gulati M, Anand V, Govila V, Jain N, Rastogi P, Bahuguna R, et al. Periodontio-integrated implants: A revolutionary concept. Dent Res J 2014;11(2):154-62.
13. Polimeni G, Xiropaidis AV, Wikesjö UM. Biology and principles of periodontal wound healing/regeneration. Periodontology 2000. 2006;41(1):30-47.

14. Pinkerton MN, Wescott DC, Gaffey BJ, Beggs KT, Milne TJ, Meikle MC. Cultured human periodontal ligament cells constitutively express multiple osteotropic cytokines and growth factors, several of which are responsive to mechanical deformation. *Periodontal Res* 2008;43(3):343-51.
15. Warrer K, Karring T, Gotfredsen K. Periodontal ligament formation around different types of dental titanium implants. I. The self-tapping screw type implants system. *J Periodontol* 1993;64(1):29-34.
16. Urabe M, Hosokawa R, Chiba D, Sato Y, Akagawa Y. Morphogenetic behavior of periodontium on inorganic implant materials: An experimental study of canines. *J Biomed Mater Res* 2000;49(1):17-24.
17. Choi BH. Periodontal ligament formation around titanium implants using cultured periodontal ligament cells: a pilot study. *Int J Oral Maxillofac Implants* 2000;15(2):193-6.
18. Guarnieri R, Giardino L, Crespi R, Romagnoli R. Cementum formation around a titanium implant: a case report. *Int J Oral Maxillofac Implants* 2002;17(5):729-32.
19. Nyman S, Gottlow J, Karring T, Lindhe J. The regenerative potential of the periodontal ligament. *J Clin Periodontol* 1982;9 (3):257-65.
20. Annie Ling Sie Kiong, Dr.Rhadika Arjunker: Tissue-engineered Ligament: Implant constructs for Tooth Replacement (Ligaplants).