WHAT'S NEW ABOUT IMPLANTS? LIGAPLANTS?

Authors:

Dr. Madhavi T.[1]
Dr. Mathew John[2]
Dr. Aswathy S.[3]
Dr. Ayswaria B.[4]

Address for correspondence:

Post Graduate Student
Department of Periodontics
Sri Sankara Dental College
Akathumuri, Varkala, Kerala

Professor
Department of Periodontics
Sri Sankara Dental College
Akathumuri, Varkala,Kerala

Senior Lecturer
Department of Periodontics
Sri Sankara Dental College
Akathumuri, Varkala,Kerala

Post Graduate Student
Department of Periodontics
Sri Sankara Dental College
Akathumuri, Varkala, Kerala

Address for correspondence:
Dr. Madhavi T.
Post Graduate Student
Department of Periodontics
Sri Sankara Dental College
Akathumuri, Varkala, Kerala
Contact: +91 9846601993
Email: madhavi.thara@gmail.com

ABSTRACT

A tissue-engineered periodontal ligament (PDL) around implants would represent an important new therapeutic tool to replace lost teeth. The PDL is the key to tooth anchoring; it connects tooth root and alveolar bone, and it sustains bone formation. The 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. Such advancement would revolutionize implant dentistry and would be significantly beneficial to patients.

Key words: Ligaplants, Dental implants

J Ind Dent Assoc Kochi 2019;1(3)15-20.

INTRODUCTION

Dental implants have become ideal replacements for missing teeth. However, despite good success rates of osseointegrated oral implants, failures do occur, which can be attributed to the bone loss due to excessive occlusal load or infection. Hence, the focus of implant dentistry has changed from merely obtaining osseointegration to the preservation and prevention of peri-implant hard and soft tissue loss. The field of oral and periodontal regenerative medicine has recently undergone significant advancements, the presence of a periodontal ligament allow for a more dynamic role beyond the functionally ankylosed implant. Therefore, the innovative approach is the creation of "periodontio-integrated implants" i.e., an implant suspended in the socket through periodontal ligament as opposed to functionally ankylosedosseo integrated implants. Hence these implants called as 'ligaplants' 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.

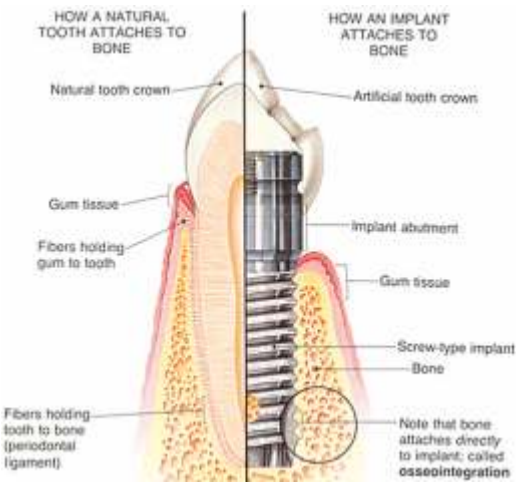

Fig 1. Interphase of Implant and bone5

The presence of periodontal ligament fibres around the tooth have significant role in the transmission of the masticatory forces to the surrounding bone. In case of dental implants, due to the absence of periodontal ligament fibres, the forces are not dissipated equally and effectively as in case of natural teeth. Hence the tissue engineering process can create an environment around the implant similar to that of the natural teeth. Apart from its role in tooth anchoring, the periodontal ligament (PDL) provides progenitor cells for alveolar bone formation and remodelling; at the bone side facing the tooth root, the PDL plays the role of the periosteum. Periodontal disease with tissue destruction by inflammation often leads to resorption and loss of alveolar bone, which may be followed by tooth loss. In contrast, a functional PDL induces bone, even at ectopic sites.[8]

A possible approach to the replacement of lost teeth is tissue engineering of the PDL. In support of the feasibility of this concept, the PDL has been shown to possess a capacity for spontaneous regeneration, during which the biomechanical tissue strength is restored, and innervations is re-established. After clinical tooth transplantations, a new functional PDL can be regenerated, apparently from PDL tissue accompanying the transplanted tooth. Even after transplantation at sites with deficient bone, restoration of alveolar bone has been observed, along with the recovery of functional tooth anchoring.[8]

Currently, to replace lost teeth without considering the PDL, implants of inert biomaterial are directly inserted into jawbones. In these procedures, local bone defects and generally poor bone quality necessitate bone reconstruction before implantation, and localized bone loss around the implant fixture represents a clinical challenge. A further, commonly observed problem is gingival recession, possibly due to modified tissue architecture, which requires further surgical interventions.[8]

An implant system that would include a PDL with tissue-inducingproperties might alleviate these problems. Technically, implants carrying a PDL may be installed in the extraction socket of the missing tooth, thereby facilitating the surgical procedure. Natural implant anchoring

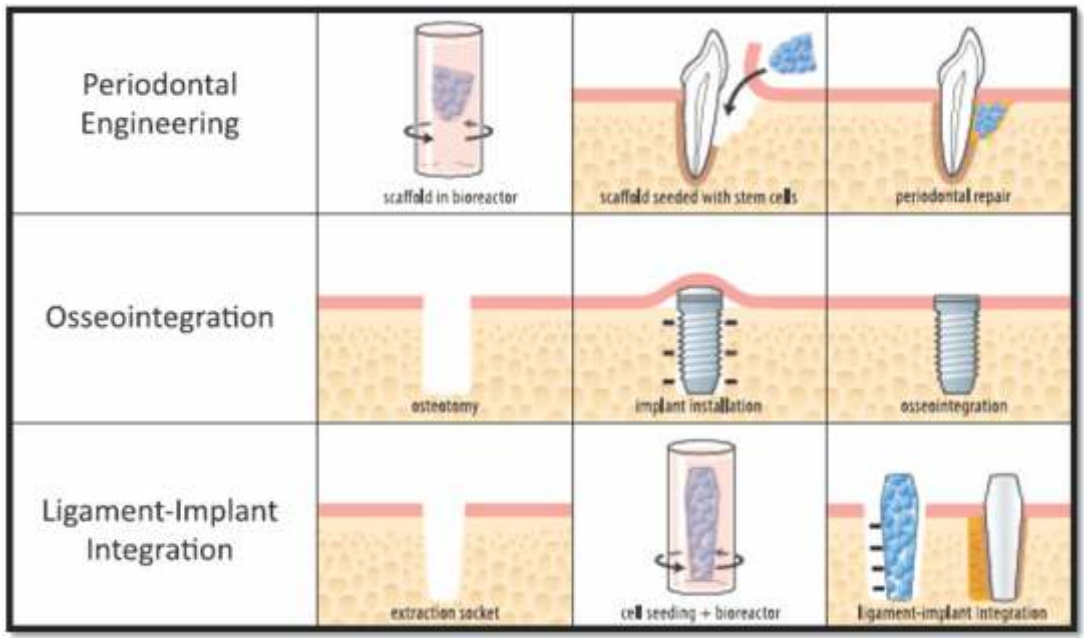

Fig 2. Interphase of Implant and ligaplant5

might also be compatible with further growth and development of the alveolar bone housing, and it may allow tooth movements during orthodontic therapy.[8] Such implants are called 'ligaplants'. Ligaplants have the capacity to induce the formation of new bone, when placed insites associated with large periodontal bone defects.[8]

In the field of dental implants, tissue engineering is an innovative technique. This was proposed by Langer and colleagues in 1993for the regeneration and restoration of the lost tissue. In 1982, Nyman et al., demonstrated that PDL cells could be used to re-establish connective tissue attachment to teeth.6Tissue-specific characteristics were acquired after implantation, which includes a new cementum-like layer, typical for regenerated PDL, orientation of cells and fibres across the non-mineralized peri-implant space. PDL organization thus induced the cooperation of the tissues surrounding the liga plant site.

The fibroblasts of the periodontal ligament have the ability to proliferate and differentiate into the cementoblasts, thereby forming cementum. The alveolus surrounding ligaplants also suggests the osteogenic potential of the periodontal ligament fibres. Regeneration of the PDL likely emanates from PDL progenitor cells, which can assemble new PDL-likestructures in vivo. Regeneration proceeds with anew layer of cementum, attached to the original cementum of the tooth root, into which new transverse fibres are integrated. Importantly, if a new cementum layer were to be laid down on the surface of an engineered device, this would accommodate the integration of a properly attached PDL with the potential to stimulate the regeneration of adjacent alveolar bone.[8] Tissue engineering helps in periodontal ligament formation, thus covering the implant surface, thereby giving rise to a new concept of oral implantology.[11]

LIGAPLANTS

The ligaplant system mimics the natural tooth roots in alveolar bone. Without interlocking and without direct bone contacts, they become firmly integrated into the bone despite the initial fitting being loose in order to spare the PDL cell cushion. Thus, the surgical procedure for ligaplants seems to be easy. It also induces the formation of new bone even when placed in sites associated with large periodontal defects, precluding the need for bone grafting as well as eliminating other problems such as gingival recession and bone defects of the missing tooth site. Therefore, these implants could be placed where periodontal bony defects are present.[5]

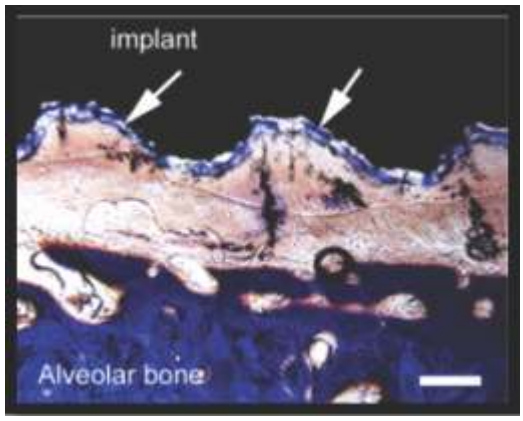

Fig 3a, Ligaplant Fig 3b, Ligaplant

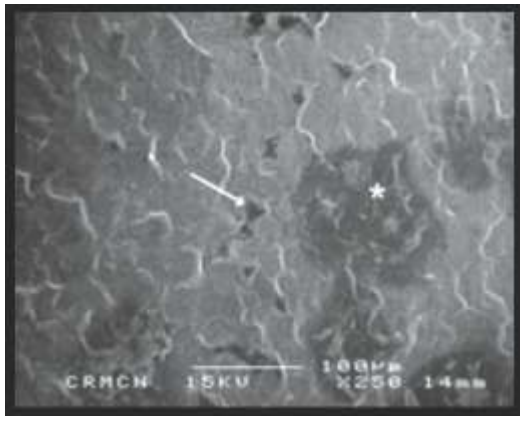

Fig 3a. Ligaplants, Masson's trichrome staining; a new layer of dense collagen covered the ligaplant (arrows), and a PDL-like tissue had been formed with perpendicular fibres between implant and alveolar bone.

Fig 3b. Ligaplants, Scanning electron microscopy of ligaplant, Overview, showing the structured ligaplant surface covered with apatite deposits (lighter) and apatite-deficientregions (darker,*), as well as minor gaps in the apatite layer (arrows).

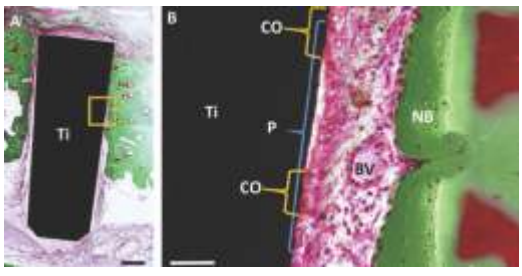

Fig 4a. Ligaplants8
Fig 4b. Periodontal tissue formation around titanium implant in dog.13

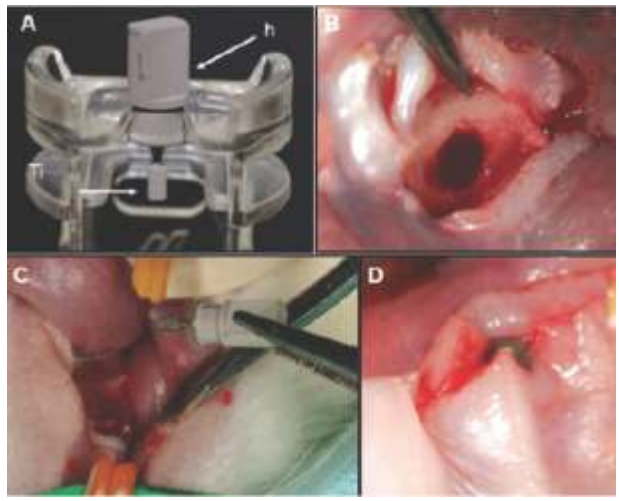

Fig 5. Rat maxillary molar titanium implant model.3
Fig 6. Ligaplant, radiography.8

Fig 5. (A) Straumann designed specialized titanium implant (Ti) and handle (h), arrows. (B) Animal preparation for implant placement. (C) Placement of cellseeded Ti implant. (D) View of implant after placement.

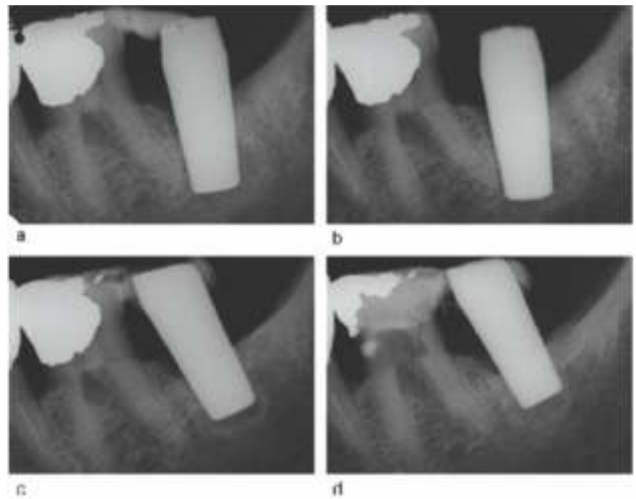

Fig 6. (a) After 2 weeks, (b) after 8 weeks (c) after 2 years and (d) after 4 years.

Preparation of Ligaplant

Polysterene culture dishes conataining N-isopropyl acylaminde monomer and 2 propanolol solution are exposed to Area Beam Electron Processing System (ABEPS). Then the ungrafted monomer is removed by rinsing culture plates with cold water. 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. 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. Harvesting of the periodontal ligament cells sheet is done on temperature responsive culture dishes at 37°C and a cell density of 1x105. 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.[9]

ADVANTAGES OF LIGAPLANTS

1. It alleviates problems like gingival recession and bone defects of missing tooth.

2. Mimics natural tooth roots inalveolar 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.

4. Bone formation was induced and movements of ligaplants inside the bone suggests an intact communication between bone and implant surface.[10]

DISADVANTAGES OF LIGAPLANTS

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 difficulty evokes during the culturing, the ligaplants may fail as other non-periodontal cells may develop.

2. 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 implantor the growth of PDL in the socket is unpredictable, which may result in failure of implant.[10]

CONCLUSION

Ligaplants as tooth replacement seems to be the next advancement and it is more likely to enhance the long-term stability of the implants. Tissue engineering of the PDL around implants has been a proof-ofconcept, the two important inter tissue interactions: firstly, the formation of a functional PDL is dependent on the implantation site, and secondly, ligaplant scan induce the formation of bone in the vicinity.

Ligaplants as tooth replacements have decisive advantages as compared with osseointegrated devices, due to their potential for periodontal tissue regeneration. It is proposed that therapeutic success requires the ability of a high proportion of the cultivated cells to organize into a new PDL. The ligaplant surgery is relatively easy, because the implant is not tightly fitted into its site. Future clinical use of ligaplants might avoid bone grafting with its expense, inconvenience, and discomfort for the patient. Further research on humans with long-term follow-up could only validate the feasibility and success of ligaplants.

REFERENCES

1. Buser, D., Warrer, K., Karring, T. & Stich, H. (1990) Titanium implants with a true periodontal ligament: an alternative to osseointegrated implants? International Journal Oral Maxillofacial Implants 5, 113–116.
2. Choi, B. H. (2000) Periodontal ligament formation around titanium implants

using cultured periodontal ligament cells. International Journal Oral Maxillofacial Implants 15, 193–196.

3. Y. Lin, G.O. Gallucci, D. Buser, D. Bosshardt, U.C. Belser, and P.C. Yelick. Bioengineered Periodontal Tissue Formed on Titanium Dental Implants; J Dent Res 90(2):251-256, 2011.
4. Warrer K, Karring T, Gotfredsen K. Periodontal ligament formation around different types of dental titanium implants.1. The self tapping screw type implant system. J Periodontol 1993; 64:29-34.
5. Giannobile WV. 2010. Getting to the root of dental implant tissue engineering. J ClinPeriodontol. 37(8):747–749.
6. Nyman S, Gottlow J, Karring T, Lindhe J. The regenerative potential of the periodontal ligament. J ClinPeriodontol 1982;9:257-65.
7. Ripamonti U. Recapitulating development : A template for periodontal tissue engineering. Periodontal Tissue Engineering 2007; 13(1): 51-71.
8. Gault P, Black A, Romette JL, Fuente F, Schroeder K, Thillou F, Brune T, Berdal A, Wurtz T. 2010. Tissue-engineered ligament: implant constructsfor tooth replacement. J ClinPeriodontol. 37(8):750–758.
9. Wurtz T. Tissue-engineered ligament: implant constructs for tooth replacement. J ClinPeriodontol 2010; 37: 750–8.
10. Ritunja Singh, Swati Raj, Gangesh B. Singh, Anand Mohan Nikunj ,ShilpaChaurasia. Ligaplants:Periodntio – Integrated Implants. Journal of Dental and Medical Sciences (IOSR-JDMS) Volume 18, Issue 7 Ser. 7 (July. 2019), PP 61-64.
11. Bharathi D, Siji JT, Srinivasan, Senthil KS. Ligaplants- A review. Annals of dental speciality 2017; 5(2): 71-3.
12. Kiong ALS, Arjunkumar R. Tissue-engineered ligament : Implant constructs for tooth replacement (Ligaplants). J Pharm Sci Res 2014;6:158-60.
13. Kengo Iwasaki, Kaoru Washio, Walter Meinzer, Yuka Tsumanuma, Kosei Yano, Isao Ishikawa. Application of cell-sheet engineering for new formation of cementum around dental implants;Heliyon 5 (2019) e01991.