LIGAPLANTS-RECREATION OF A NATURAL LINK IN IMPLANT DENTISTRY

[1] Aathira.R.Nair,[2] Dr.P.L Ravi Shankar,[3] Dr.M.Prem Blaisie Rajula,[4] Dr.Gayathri.K
[1] Intern, Department of Periodontics, SRM Kattankulathur Dental College &Hospital, Potheri- 603203, Tamilnadu, India
[2] Professor & Head Of The Department, Department of Periodontics, SRM Kattankulathur Dental College &Hospital, Potheri- 603203, Tamilnadu, India
[3][4] Lecturer, Department of Periodontics, SRM Kattankulathur Dental College &Hospital, Potheri- 603203, Tamilnadu, India

To access & cite this article

Website: tmjpds.com

ABSTRACT

For the past decade, using dental implants to substitute the missing teeth has been the gold standard of care. The osseointegrated implants, which are currently the most popular implants, have a number of disadvantages, the most notable of which is the absence of the periodontal ligament. To counteract this, periodontal ligament implants were developed, made possible by the integrating the tissue engineering idea with the right implant material.
A ligaplant is a tissue designed periodontal ligament that wraps around a dental implant and is called a ligaplant. These ligament implants have emerged as a potential option capable of providing good biological performance, resulting in a longer prosthetic life. PDL is home to a variety of essential cells that play a critical role in the dynamic connection between the tooth and the bone. This review article discusses the advantages of periodontal ligament-coupled dental implants over traditional implants, as well as the method of creating a high-performance ligament implant.

Key words: Dental implants, ligaplants, periodontal ligament, tissue engineering.

INTRODUCTION

The expansion of implant dentistry is linked to many factors, including increased life expectancy in the elderly, problems with removable dentures and fixed teeth, and the benefits and predictable outcomes of employing implants(1). When natural teeth are extracted, periodontal ligament (PDL) cells are lost. Therefore, these cells are unable to take part in the healing of wounds around endosseous implants that are placed to replace missing teeth.

As a result, at this time, close bone-to-implant contact, or osseointegration, is thought to promote the best healing surrounding implants. For past decades, osseintegrated implants have been used for replacing missing teeth. Due to their high long-term clinical survival rate, these have been a significant additions to the discipline of dentistry and have yielded successful results. But these osseointegated implants also had some limitations which lead to new inventions. One of the most important drawback was the lack of PDL and to overcome this, a formulation was designed using tissue engineering along with a suitable implant material to create “Ligaplants”(2).

Compared to natural teeth with PDL, osseointegrated implants(fig1) are “ankylosed” and physiological movement and proprioception is missing , many attempts are done to compensate for the lacking abilities of osseointegrated implants to mimic natural teeth using “shock-absorbing systems” built into the implant(3).

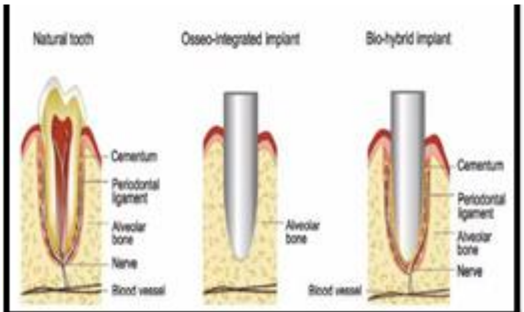

Fig1:Differentkindsofintegrationseeninnatur altooth,osseointegratedi

TISSUE ENGINEERING

Tissue engineering has emerged as a game-changing method for creating scaffolds composed of biodegradable polymers and growth factors that can aid in tissue formation. The notion of tissue engineering is understood as a triangle by fusing three basic components, stating that the combination of these factors promotes regeneration (5).

Principle Constituents of tissue engineering (fig 2)

- ❖ Matrix
- ❖ Scaffold
- ❖ Signalling molecules

Scaffolds serve as three-dimensional structures that facilitate cell migration and proliferation, leading to matrix synthesis and tissue development. (4) Before being transplanted into the body, the cells are cultured with signalling molecules over a biodegradable matrix and scaffolds. This is known as the in-vitro procedure. On the other hand, the body's physiological healing mechanism leads to regeneration once the produced vital ingredients are deposited in tissue flaws. This method, known as the in vivo technique, uses these three components of tissue defect locations to induce intrinsic healing activity. Both in vivo and in vitro methods can be used to obtain ligaplants. (Fig 3)

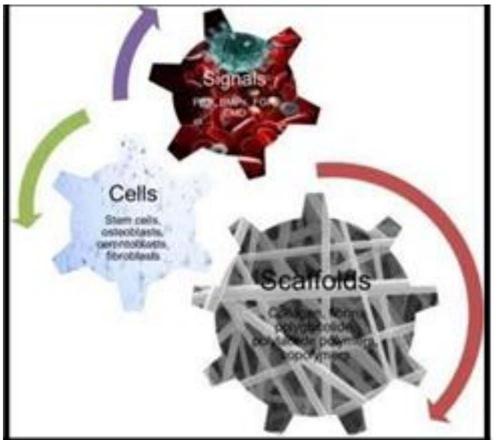

Fig2:Principleconstituentsoftissueen gineering

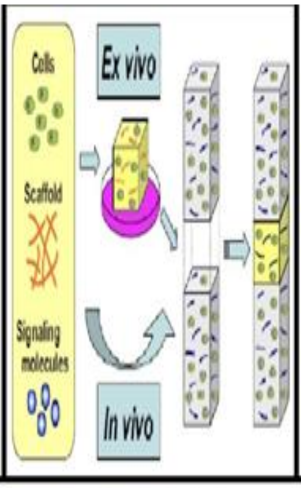

Fig3:Ex-vivotechnique-fortheformationoftheorgansandthetissuesinacultureroombyamalgamationofthescaffold,cellsin signalling molecules prior to the transplantation of newly tissue-engineered organs to the patient's body .In-vivo

PREPARATION OF LIGAPLANTS

Using tissue engineering around artificial roots, a new concept was introduced to create ligament grafts through the following three steps:

N-isopropylacylamide monomer in 2-propanalol solution is applied to polystyrene culture dishes. The dishes are then irradiated with an electron beam using an Area Beam Electron Processing System.After rinsing with cold water to remove ungrafted monomer, the plates are sterilised with ethylene oxide (19).

Isolate human periodontal ligament cells from extracted teeth. The periodontal tissue is scraped off with a scalpel blade after it has been extracted from the middle third of the root. Harvested tissues are placed in culture dishes containing Dulbecco's Modified Eagle's Minimum Essential Medium supplemented with 10% fetal bovine serum and 100 units/ml penicillin-streptomycin. Culture these adult cells to adhere the cells to the dish for 48 hours at 37 °C in a humidified atmosphere of 5% CO_2.Precipitates are removed by rinsing the dishes and medium should be changed three times a week. To harvest the cell layer, human periodontal ligament cells were placed in temperature-sensitive 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 (10)that function as an osteodifferentiation media(11).

A hydroxyapatite (HAP) coated titanium pin is inserted into a hollow plastic cylinder, with a 3mm space surrounding the pin. Culture media is continuously injected via the gap. Human single cell suspension is seeded initially into plastic tubes with a flow of growth media for 18 days (12). (Fig 4, 5)

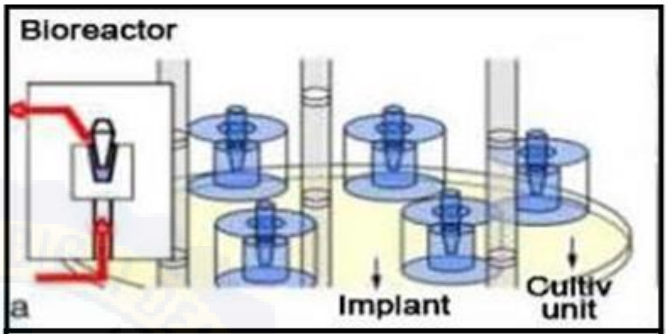

Fig5:Bioreactor

ADVANTAGES

- ❖ It works as a shock absorber
- ❖ Amount of bone loss in peri-implantitis is reduced
- ❖ Reduces problems like gingival recession and bone abnormalities of the missing tooth(15)
- ❖ Ligaplants adhere securely without locking or coming into direct touch with the bone, mimicking natural tooth insertion despite initial adjustment being loose to spare PDL cell cushion(6).

DISADVANTAGES

- ❖ Ligaplants are too expensive
- ❖ Culturing should be done with caution(13)
- ❖ Factors influencing the host's acceptance of the implant or the PDL growth in the socket cannot be predicted. (7).

OSSEOINTEGRATION vs PDL INTEGRATION

PDL provides fine movements and functions as a shock absorber which helps in distributing the forces between implant supported prosthesis and natural teeth abutments.The conventional bone-integrated implants lacks fibrous capsule, the interfacial layer at the titanium-bone interface is rich in collagen and plasma proteins. The plasticity and bone remodelling ability of a natural teeth are not present in conventional implants and these implants possess rigid bone- implant interface leading to loss of marginal bone.

Whereas, Ligaplants help in the formation of new cementum on implant surface along with periodontal attachment apparatus consisting of PDL fibers and sharpeys fibers. This allows bone remodelling(11).

PRECAUTIONS WHILE PREPARING LIGAPLANTS

❖ It is imperative to maintain proper sterility throughout the procedure(14).

❖ To forbid the development of non-periodontal ligament cell types, an

optimal culture methodology and perfect cell growth are required.

❖ Small mechanical motions/vibrations of the growth media are essential for firm integration of the implant.

❖ For successful ligament implant results, the optimal time for surface preparation must be pre-determined (13).

LITERATURE SUPPORTING LIGAPLANTS(8)

Gault P in 2010 performed a characteristic study in which cells were isolated from the PDL of humans and dog models. These cells were cultured in a bioreactor on titanium pins. The pins were then implanted in an enlarged alveolus.

The following results were obtained from the study:

❖ Histological examination of dog models displayed that the cells were arranged in a typical ligament-like fashion.

❖ In human patients the probing and motility assessments suggested

that the implants are well integrated with the mechanical properties

❖ Radiographic findings revealed the regeneration of deficient alveolar bone, the development of lamina dura adjacent to the mineral devoid space around the implant and implant migration in intact bone structure.

SUCCESS OF LIGAPLANTS

Site-specific signalling mediated by an anatomical code written in the expression pattern of homeogen-encoded transcription factors is a key component for generating regenerated periodontal ligaments. As a result homeoproteins influence the production of cell surface and signalling components. The signals from the surface of the cell react to modify homeogene, that results in the establishment of the cell identities. Asporin extracellular matrix found SLRP protein has been found to play a role in this process (9).

CONCLUSION

● Introduction of implants with PDL attachments has created a revolution in the domain of implant dentistry.

● Most of the studies has been conducted in animals and have given successful results.

● More human studies need to be conducted to assess the success of this strategy.

ACKNOWLEDGEMENT

The authors are grateful to the authors/editors/publishers of all the articles and journals from where the literature for this article has been reviewed and discussed.

CONFLICT OF INTEREST

Nil

FUNDING

Nil

Engineering”. IJDSIR2020361624

REFERENCES:

(1) Chen F, Terada K, Handa K. Anchorage effect of various shape palatal osseointegrated implants: A finite element study. Angle Orthod. 2005;75:378–85. [PubMed] [Google Scholar]

(2) 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;37:750–8. [PubMed] [Google Scholar]

(3) Kirsch A. The two-phase implantation method using IMZ intramobile cylinder implants. J Oral Implantol. 1983;11:197–210. [PubMed] [Google Scholar]

(4) D Philips N Pandit R Malik Tissue engineering: A new vista in periodontal regenerationJ Indian Soc Periodontol20111543283710.4103/0972-124x.92564

(5) Aeran, H. and Tuli, A.S., 2021. Anamika. Ligaplants: Recreation of a natural link in implant dentistry: A review. Int. J. Oral Health Dent, 7(1), p.37.

(6) Benjamin A, Mahajan R, Sura S, Suthar N. 'Ligaplants' The next generation implants. IJIRS. 2014;3:571–9. [Google Scholar]

(7) Arunachalam LT, Uma S, Merugu S, Janarthanan AS. Tissue-engineered periodontal ligament on implants: Hype or a hope? J Dent Implants. 2012;2:115–6. [Google Scholar]

(8) Gault P, Black A, Romette J-L, Fuente F, Schroeder K, Thillou F, Brune T, Berdal A, Wurtz T. Tissue-engineered ligament: implant constructs for tooth replacement. J Clin Periodontol 2010; 37: 750–758. doi: 10.1111/j.1600-051X.2010.01588.x.

(9) S Jaryal S Pumma G Kaur Ligaplants-A new ray of hope uncovering the potential ofTissue

(10) D Bharathi JT Siji SS Kumar Ligaplants – A reviewAnn Dent Speciality201752713

(11) J Jibi BL Rao YSS Sruthi T Pratyusha C Chitra A Novel Approach in Implant Dentistry-LIGAPLANTSInt J Sci Res201983435

(12) CMR Rizwanulla S Padmaja M Dayalan Ligaplant- An era of third dentitionProsthetic Implant Dent2019226973

(13) R Singh S Raj GB Singh AM Nikunj S Chaurasia Ligaplants: Periodntio-

Integrated ImplantsJ Dent Med Sci2019187614

(14) (2023). 'LIGAPLANTS – HOW FAR ARE WE FROM IT', European Journal of Molecular & Clinical Medicine, 10(3), pp. 388-396.

(15) Saleem M, Kaushik M, Ghai A, Tomar N, Singh S. Ligaplants: A Revolutionary Concept in Implant Dentistry. Ann Maxillofac Surg. 2020 Jan-Jun;10(1):195- 197. doi: 10.4103/ams.ams_58_19. Epub 2020 Jun 8. PMID: 32855940; PMCID: PMC7433942.

(16) Aeran H, Tuli AS. Anamika. Ligaplants: Recreation of a natural link in implant dentistry: A review. Int. J. Oral Health Dent. 2021;7(1):37.