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Ligaplant- A Tissue Engineered Implant- A New Era of Implant Dentistry

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ABSTRACT:

In today's world tooth replacement with implants has evolved as one of the most reliable and challenging field because of its newer innovations and proven success. Tissue engineering, has changed the outlook of implant dentistry especially with periodontal tissues. 'Ligaplants' have recently been introduced to overcome the limitations of conventional implants. Though it has certain limitations, the future of ligaplants seems to have promising future.

1. Introduction

One of the treatment modalities after tooth loss is replacement with the dental implants. From the past decade this treatment modality has gained popularity due to a combination of various reasons: prolonged life span of aging individuals, failures associated with removable and fixed prostheses, advantages, and predictable outcomes associated with the use of implants. [1]. As the periodontal ligament (PDL) cells are lost after loss of tooth, these cells cannot participate in wound healing around endosseous implants. So now a days intimate bone-to-implant contact is considered as optimal healing, called osseointegration.1 These osseointegrated implants are the most popular implants in today's world, but it has many limitations including the lack of the periodontal ligament. The application of the tissue engineering concept along with suitable implant material may overcome this problem by producing implants with periodontal ligaments. Tissue engineering not only has become an crucial part of the periodontal therapy but also has made various opening in dentistry. A ligaplant is a dental implant which has tissue engineered periodontal ligament around it. These ligaplants can provide good biological performance by increasing the life of the prosthesis. Ligaplants (FIG 1) are a new treatment modality, which are being clinically tried in vivo and in vitro. They have shown good results in animal studies, but in vivo results are yet to be correlated. Several successful experiments have been conducted to ligaplant that can maintain form, function and potential proprioceptive responses like a natural tooth. These strong evidences suggest that, the future of such implant is bright and that would revolutionize the implant dentistry and accepted by the patients.

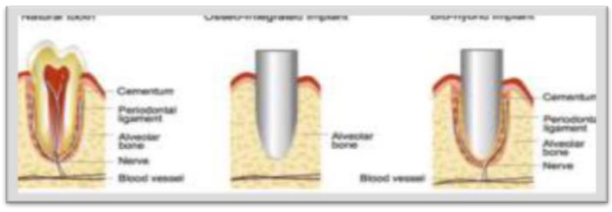

FIG 1: Ligaplant as new treatment modality for osseointegration

2. Objectives

In this review article the procedure of the procurement of ligaplant along with their advantages and shortcomings are discussed.

3. Methods

The combination of periodontal ligament cells and implant biomaterial is called ligaplants. The periodontal ligaments that are formed around ligaplants help the

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micro movements and shock absorption contrary to the conventional implants. They also help in the distribution of forces among the teeth abutments and the prosthesis supported by the implants. The limitations of the conventional implants are overcome by the use of ligaplants. Better physiological responses are provided by them like natural tooth by similar form and functions, which can lead to increased lifespan of the prosthesis. Properties of ligaplants- It provides some movement in the socket and acts like a shock absorber. It also provides proprioception. At the bone side facing the root. the periodontal ligament also plays the role of the periosteum, It contains vital cells such as osteoclasts, osteoblasts, fibroblasts, cementoblasts, cementoclasts, and most importantly, the undifferentiated mesenchymal stem cells. These cells maintain the dynamic relationship between the tooth and the bone. Advantages- In spite of the initial fitting of being loose to spare PDL cell cushion, ligaplants become firmly integrated without interlocking and without direct bone contact.[2]Ligaplants removes the problems like gingival recession and bone defects of the missing tooth. It is similar in natural insertion of natural tooth roots in the alveolar process. Disadvantages- The temperature, the cells that are used for culturing, the duration of the culturing, and others are very crucial So the culturing of ligaplants should be done very cautiously. Problems during the culturing may result in failure of the ligaplants as other non-periodontal cells may develop. The cost of this implant also raises due to limited facilities which also restricts its usage. Other limitation of the ligaplants are that the host acceptance factors to the implant or the growth of PDL in the socket is unpredictable, which may result in failure of implant [3]. The prolonged cell culturing may also results in the appearance of non-PDL cell types.[4]

4. Procedure

One of the best examples of healing capacity is transplantation of tooth with double PDL stimulation. Before fourteen days of transplantation the donor tooth is extracted and immediately replanted in its original alveolus. Cell proliferation and differentiation takes place as this deliberate trauma triggers a healing process within the PDL. The transplantation of the tooth can be performed with millions of cells attached to its root by new Sharpey's fibers after 14 days, when the cell culture reaches its peak of activity. Buser et al. [5] suggested that titanium dental implants when placed in contact with retained root tips, the PDL of these roots served as a source for cells which could populate the implant surface during healing. Now, tissue engineering (FIG 2,3,4) has opened a new horizon in periodontal regeneration and more so in the field of dental implants. Various scaffolds and matrices have the ability to regenerate the entire periodontium. In another study, Gault et al. [4] used ligaplants (combination of PDL cells with implant biomaterial) for tooth replacement. The study involved animal experiments on mice and canine models as well as human clinical investigation. In the canine model, PDL formation was observed and a new layer of tissue resembling repair cementum was formed on the ligaplant surface. In humans, after surgery, a desmodontal gap, corresponding to PDL space of normal width, was evident around one ligaplant, and the structure of the lamina dura resembled that around a natural tooth. In one ligaplant, radiographs indicated that it had moved inside apparently intact bone, indicating the presence of newly formed PDL.In the field of periodontal regeneration, debates still exist on the type of cells possessing the capability of forming new cementum on previously exposed root surfaces. Some authors reported [2,5] that cells residing in the alveolar bone are responsible for cementum production, whereas other investigators [5,6] suggested that only PDL cells can produce cementum, revealing the significance of PDL around dental implants.[7] Kiong and Arjunkumar[8] stated that ligaplants as tooth replacement have decisive advantages as compared with osseointegration devices, due to their periodontal tissue regeneration. The ligaplants surgery is moderately simple, because the implant is not tightly fitted to its site. Besides that, the patient may not have to undergo bone grafting, inconvenience, and discomfort with the ligaplants placement.

5. Discussion

The important elements required for reconstruction and regeneration of Periodontal ligament are matrix or a scaffold signaling molecules and cells. Using in vitro technique tissues prepared in laboratory are cultivated. The cells are cultured on the biodegradable scaffolds or matrix with the help of signaling molecules. Then they are transplanted into the body. While using in vivo technique, all the cultivated vital elements are placed in a tissue defect and they undergo a natural healing process in the body giving rise to regeneration. It induces

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intrinsic healing activity at the site of tissue defect using the three elements.

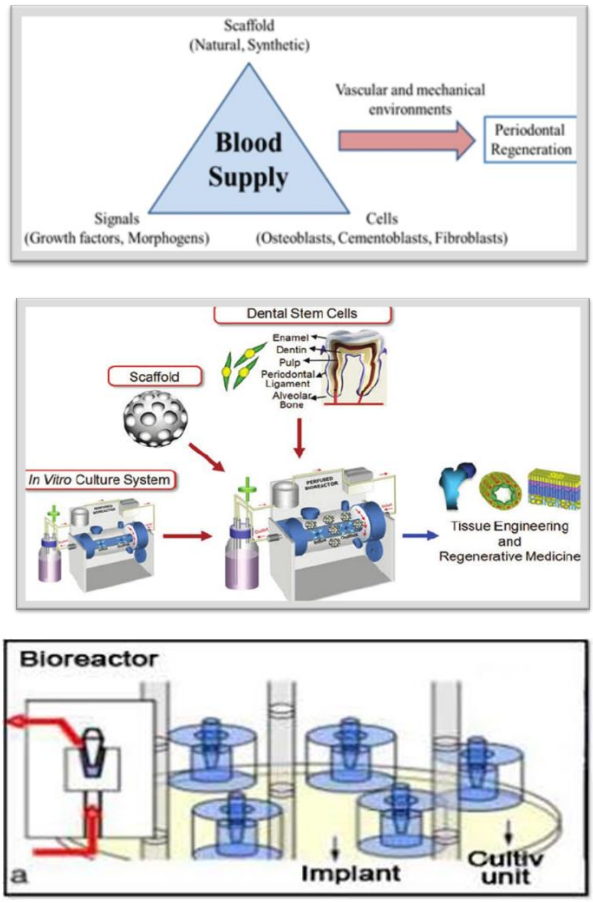

FIG 2,3,4: process of ligaplant formation by tissue engineering

Success rate of the ligaplants-The development of a regenerative PDL depends on site-specific signaling, which in turn is mediated by an anatomic code, written in expression patterns of homeogene-coded transcription factors. Hence, the homeoproteins influence the synthesis of cell surface and signaling components, and signals from the cell surface feedback to modulate homeogene expression, whereby cell identities are established according to the anatomic site and tissue type.[9] Risk factors of ligaplants-The development of PDL for the generation of PDL depends majorly on site signaling, which is largely mediated by anatomic code and homeogene-coded transcription factors. These homeoproteins are essential for the synthesis of cell surface and signaling components. As the factors affecting the growth of PDL in the desired site are often unpredictable, so it becomes a major risk factor for the treatment outcome.

Conclusion- Based on the tissue engineering, ligaplants have been recently introduced to overcome the limitations of the osseointegrated implants. Though majority of the animal studies have shown promising results, periodontal ligament attached implants is now recently introduced. Further human trials follow-up can gain the success of ligaplants. As ligaplants has various advantages in comparison to conventional implants, these can emerge as a new era to the implant dentistry in future.

Refrences

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
2. Benjamin A, Mahajan R, Sura S, Suthar N. 'Ligaplants' The next generation implants. IJIRS. 2014;3:571–9.
3. 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.
4. 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
5. Buser D, Warrer K, Karring T. Formation of a periodontal ligament around titanium implants. J Periodontol. 1990;61:597–601. 5. Kirsch A. The two-phase implantation method using IMZ intramobile cylinder implants. J Oral Implantol. 1983;11:197–210.
6. 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.
7. Isidor F, Karring T, Nyman S, Lindhe J. The significance of coronal growth of periodontal ligament tissue for new attachment formation. J Clin Periodontol. 1986;13:145–50.
8. Kiong AL, Arjunkumar R. Tissue-engineered ligament: Implant constructs for tooth replacement (Ligaplants) J Pharma Sci Res. 2014;6:158–60.
9. Kirsch A. The two-phase implantation method using IMZ intramobile cylinder implants. J Oral Implantol. 1983;11:197–210.