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Review Article | Prosthodontics

LIGAPLANTS: FICTION OR FAKE!!!

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ABSTRACT In today's restorative dentistry, replacement of missing tooth/teeth with implants has evolved as the most reliable and challenging field through spectacular innovations with proven success. With the advent of tissue engineering, the outlook of implant dentistry has transformed especially with periodontal tissues. 'Ligaplants' unlike traditional implants have recently been introduced to address the shortcomings of conventional implants. Though there are pitfalls, future seems to be more promising with ligaplants that could revolutionize implant dentistry to a greater extent.

KEYWORDS : Implants, ligaplants, tissue engineering, osseointegration

INTRODUCTION:

Dental implants are progressively becoming the choice for replacing the missing teeth, though the complications associated with them are emerging too. With the advancements in technology, modern implant therapy has also taken a quantum leap by placing periodontal ligament (PDL) titanium implants in improving the biofunctionality of dental implants. [1]

'Osseointegration' is the term used in for the close bond that exists between an implant's surface and the surrounding bone. The fundamental disadvantage of the traditional implants is that, unlike natural dentition, they lack PDL. In comparison to natural teeth, osseointegrated implants are ankylosed, lack physiological mobility, and lack the capacity to absorb masticatory force (shock-absorbing). [2]

The absence of a PDL around dental implants produces difficulties in connecting the implant and natural teeth for prosthetic restorations because of their differences in compressibility during function. Although it is possible to connect the implant and natural teeth without any special consideration, bony ankylosis of the implant cause absence of proprioceptors in the periodontium associated with lack of load sensation as provided by the PDL to the patient. [3] Buser *et al.*, in 1990 exhibited that when titanium dental implants placed in close contact with the retained root tips, PDL around these retained roots served as a source for the cells that could cover the implant surface during healing. [4]

The PDL has the inherent regenerative capacity and hence implant with PDL is a new emerging epoch in the field of dentistry called as 'ligaplant', wherein tissue-engineered PDL cells are formed on the implant surface; mimicking the natural tooth. [5]

Preparation of Ligaplant:

The notion of tissue engineering is illustrated as a triad; (Fig-1) which states that by combining three primary principle elements, will enhance periodontal regeneration. The three basic elements are scaffolds or matrices, signaling chemicals, and cells. The scaffold will operate as a three-dimensional structure that allows cells to migrate and proliferate, resulting in the production of a matrix and tissue development. [5,6]

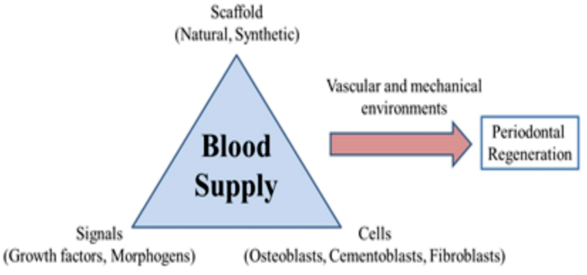

Figure-1: Tissue engineering triad

Both *in vivo* and *in vitro* procedures can be used in obtaining 'ligaplants'. In *in vitro* procedure, signaling molecules are applied to the biodegradable matrix and scaffolds, and the cells were grown before being transferred onto the implant body. In the *in vivo* procedure, on the other hand, the produced vital elements are deposited in tissue defects, followed by a physiological healing process in the implant body, which leads to regeneration. The use of these three elements at the tissue defect site generates intrinsic healing activity. [6]

Human PDL cells were isolated from a previously extracted tooth, and then replanted in its native donor site for 14 days; by that time, cell proliferation and differentiation would have taken place due to the intentional damage caused by removing the tooth from its socket. Sharpey's fibers will have reached its peak on the root surface by this point.

After extracting the tooth, periodontal tissue was grazed from the middle third of the root with a scalpel blade. The amassed tissue was placed into culture dishes containing Dulbecco's Modified Eagle's Medium (DMEM) to provide nourishment and to promote growth of the cells supplemented with 10% fetal bovine serum and 100units/ml of penicillin-streptomycin. Outgrowth cells will form, and these will be cultivated for 48 hours at 37°C in a humidified atmosphere with 5% CO_2 to help the cells to adhere to the dishes. The medium was changed three times per week and the plates were cleansed to remove any debris. Human PDL cells were seeded at a density of $1x10^5$ on temperature-responsive culture dishes with a diameter of 35 mm, and then grown at 37°C with 50mg/mL ascorbic acid 2-phosphate, 10nM dexamethasone, and 10nM ß-glycerophosphate. [1,2,7]

Culturing of PDL cells in a bioreactor:
A titanium pin, coated with hydroxyapatite (HAP) was placed in a hollow plastic cylinder maintaining a gap of 3mm around the pin. Culture medium will be pumped continuously through this gap. Single cells suspension obtained from humans was first seeded for 18 days into the plastic vessels under a flow of growth medium. Cells by positioning in a narrow space as mentioned above thus after completion of this entire process of the titanium pin coated with HAP will be called as 'ligaplant'.[7]

Bioreactors were used in culturing the primary cultures and in maintaining the 'stem-ness' of these cells over 3-weeks period *in vitro* before transplanting it to the osseous defect. [8] Stem-ness is an essential characteristic of a stem cell that distinguishes it from ordinary cells. [9] This method of cellular seeding using bioreactors allows spatial distribution of cells over the surface of implant prototype in forming ligamentous attachments. [8,10]

As a result, it was expected that the PDL phenotype would be preferred, implying a tight cell-implant connection. To acquire a successful ligaplant; the preparation should include mechanical motions of the medium flow and space between the implant and the culture, as well as the duration of the surface treatment should be optimal. Tissue engineering, on the other hand, has opened up new possibilities in PDL regeneration, particularly in the treatment of dental implants. The ability to regenerate the whole periodontium has been demonstrated via a variety of scaffolds and matrices. [11]

Advantages: [2,5,7,11]
1. Ligaplants mimics the anatomy of a natural tooth.
2. Ligaplants become firmly integrated without interlocking and direct bone contact, despite the initial fitting being loose to spare PDL cell cushion.
3. Helps in inducting the new bone formation even when placed in sites associated with large periodontal defects, precluding the need for bone grafting.
4. In the transmission of chewing forces between bone and teeth (when muscles bring in contact mandible with the maxilla, PDL transmits movement and forces to the teeth that will crunch the ailments).
5. In its bone remodeling capacity (the presence of the PDL maintains/regenerate a good quality of bone).
6. The PDL offsets lateral and vertical tooth wear during life.
7. Not only it maintains form and function, but also potential proprioceptive response more similar to natural tooth.

Disadvantages: [2,4,5]
1. Technique sensitive procedure in procuring.
2. Unpredictable host acceptance.
3. Expensive procedure.
4. Prolonged duration of culture.
5. Maintaining proper temperature.
6. Implant failure as a result of unpredictable growth of non-periodontal cells.

Rationale of Ligaplants:
Since ligaplant is a combination of PDL cells and implant biomaterial, the resultant implant allows micro-movements and shock absorption than traditional implants. They also have a positive impact on the quality of force distribution between natural tooth abutments and prosthetics supported by implants. Because these implants mimic the form and function of natural teeth, they may be able to overcome the shortcomings of traditional implants and deliver better physiological effects, thus resulting in a longer lifespan for the prosthesis. [2]

CONCLUSION:
In today's modern world of science and technology, the phrase "curiosity is the mother of invention" holds true. More successful and spectacular discoveries are rising in the sky, just like the exciting breakthroughs in implant dentistry today. The advent of periodontal tissue engineering has transformed the outlook of implant dentistry. Ligaplants have recently been introduced to address the drawbacks of traditional implants. Although, majority of animal studies on ligaplants have yielded positive outcomes, a more feasible and practical method of obtaining periodontal ligament-attached implants must be developed. Further human studies are required to assess the effectiveness of ligaplants. So, 'Ligaplants' seems to be a challenging and promising fact in implant dentistry rather than a fiction or fake.

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