

Tissue Engineering and Their Applications in Dentistry

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Abstract: Tissue engineering has become a new era in dentistry. It is a novel field that recreates healthy tissues, functional and organ in order to replace dead tissues. There are several applications of tissue engineering in oro-maxillofacial complex.

Key words: Tissue Engineering • Stem Cells • Regenerative Medicine

INTRODUCTION

Tissue engineering is an emerging interdisciplinary field, which applies the principles of, chemical, biological and engineering sciences towards the goal of tissue regeneration [1]. Tissue engineering is an excellent approach for the repair/regeneration of damaged tissue. It has the potential to evade all the limitations of allogenic and autologous tissue repair.

Tissue engineering approaches and makes use of biomaterials, cells and factors in combination or either alone to restore, maintain, or improve tissue function. The tissue engineering strategy mostly involves the isolation of healthy cells from a patient, which is then followed by their expansion *in vitro*. These expanded cells are then seeded or cultivated onto a three dimensional (3D) biodegradable scaffold which will provides structural support and this can also act as a reservoir for bioactive molecules such as growth factors[2]. The scaffold gradually degrades with time and is then replaced by newly grown tissue from the seeded cells.

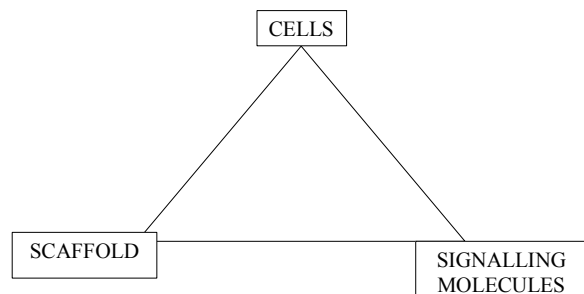
Tissue Engineering in Regenerative Medicine: The phrase regenerative medicine is frequently used to denote the replacement, repair, or functional development of tissues and organs. Regenerative medicine has conventionally used materials at hand and the technology of the day to re-establish or improve function of organs and tissues afflicted by birth defects.

The field of tissue engineering shows huge potential for regenerative medicine. It can be developed and advanced to the point that living tissues and organs can be habitually assembled and reliably incorporated into the body to restore, replace, or augment tissue and organ functions. Thus, the purpose of tissue engineering to regenerative medicine shows great promise for the treatment of a large number of conditions which includes some birth defects, Alzheimer's and Parkinson's diseases, musculoskeletal disorders, diabetes, liver and kidney failure, heart disease and spinal cord injuries. In addition to its use in regenerative medicine, tissue engineering could afford replaced tissues that could be helpful for drug discovery, development and toxicological assessment [3].

Tissue Engineering Strategies: Overview: Two main approaches are currently utilized in this area of tissue engineering to produce engineered tissue. First, scaffolding can be utilized as a cell support device upon which cells are seeded *in vitro*. Then these cells are encouraged to lay down matrix to generate the foundations of a tissue for transplantation. The next approach involves using the scaffold as a growth factor or a drug delivery device. This strategy involves where the scaffold is being shared with growth factors. Consequently, upon implantation, the cells from the body are recruited to the scaffold site, structure tissue upon and all through the matrices. These two approaches are

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not equally exclusive and can be easily combined [4]. The source of cells is also a significant choice for scaffolds, as is the culture regime used



Sources of Stem Cells: The construction of an engineered tissue *in vitro* requires the use of cells to inhabit matrices and construct matrix similar to that of the native tissue. Therefore, attention has become focused upon the application of stem cells, which includes embryonic stem (ES) cells, umbilical cord-derived mesenchymal stem cells (UC-MSCs) and bone marrow mesenchymal stem cells (BM-MSCs) [6].

Cells from the diverse variety of tissue sources can be autologous (self), allogenic (non-self, same species) and xenogenic (animal, other species). Autologous offers the benefit of manipulation with minimum risk of adverse host response and disease transmission. Allogenic, offers the advantage of banking prior to need, but is more liable to be complicated by the occurrence of disease-transmitting viruses. Xenogenic cells would be more likely to cause an adverse response from the host [7, 8].

Scaffold Design: A novel scaffold structures are important to reproduce to fabricate tissue structures as the tissue engineering progresses. The applications of biodegradable polymers, has become widespread. Nevertheless, the manner in which these polymers are processed and the additives produced at the time of manufacture allows the ultimate properties of the scaffold to be tailored. Some of the scaffold types are high-pressure CO foamed scaffolds; novel custom scaffolds and injectable scaffolds and these scaffold can be additionally modified using growth factors, donation of materials and plasma polymerization deposition.

Poly-hydroxyl acids and poly lactic-co glycolic acid (PLGA) have been widely used for tissue engineering procedures.

Growth Factors: As the scaffolds are used as the hold for cell growth, they can concurrently be used as a vehicle for

drug delivery. Theoretically, the scaffolds can be used to convey growth factors/drugs to the sites of repair, thus admitting the reparative process. Due to the kinetics and density of biological growth factor release, the process has required mandatory widespread investigation. One of the chief issues is maintaining the conformation and task of proteins during the process of scaffold fabrication.

Applications of Tissue Engineering in Dentistry: Tissue engineering has a wide application in oral and maxillofacial complex. It has a widespread application to many different types of tissues related to the oral includes cartilage, bone, skin, oral mucosa, salivary glands, dentin and dental pulp.

Most significant impact of tissue engineering in dentistry is through bone tissue engineering and regeneration. The main aim of present strategies is in replacement of bone defects by the utilization of autografts, allografts and synthetic biomaterials. Guided tissue engineering after the periodontal surgery is the conductive advance of the regeneration of bone. Bone morphogenetic protein and cell transplantation approach are used in large scale for reconstructive procedures [9].

Tissue engineering is widely used in the development of skin equivalents. After radial neck dissection, invasive cancer, severe burns and the major traumatic wounds, skin tissue is needed in adjunctive aesthetic treatment of the patients. The similar procedure is carried out in oral mucosa [10]. The development and transplantation of the gingival and oral mucosa could be important as a new technique in periodontal graft surgery [11].

The most challenging face of tissue engineering is the replacement of complete organs and replacement of salivary gland function. Gene therapy is the one method that can be used in the replacement of salivary gland function. Another method, which can be used to restore the function of salivary gland, is the cell transplantation. Recently a substitute is developed for salivary gland, which is composed of polymer tube lined by epithelium cell [12]. This device can be engrafted in to the buccal mucosa of the patients who have lost the function of salivary gland tissue. These emerging approaches can be used for treating conditions such as lost salivary gland function, rampant caries, mucosal infection and dysphagia[13].

Dental caries remains the most prevalent diseases among the childhood as well as in adult. One can potentially engineer or produce lost dentin and pulp in several ways. It is possible to induce odontoblast from the pulp tissue, (as these cells are lost due to dental

caries) by the bone morphogenic proteins [14]. It is possible to produce dental pulp by culturing fibroblast and synthetic polymer matrices.

As the emergence of craniofacial reconstruction, the plan of polymer scaffolds with distinct mechanical and degradative properties has opened a new way to cartilage reconstruction. Cartilage destruction is can be mainly associated with trauma and a number of diseases, which includes degenerative articular cartilage and destruction at the temporomandibular joint. The inadequate capacity of cartilaginous tissue to repair and the lack of inductive molecules have focused the interest among many researchers and manufacturers in mounting cell transplantation approaches to regenerate cartilage [15, 16].

CONCLUSION

The current objective in clinical approach is to replace the tissue and to reconstruct and restore the function and mechanical stability. Current trend deals with the proper utilization of autogenous grafts, allograft and synthetic materials. The promise of tissue engineering in dentistry is great. It currently incorporates a multidisciplinary approach and integrates current concepts in molecular biology, cell biology, bioengineering and biomaterials. So now, it has become a new era in dentistry and we should speculate the use of tissue engineering in regenerating dental tissues.

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