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The Novel Application of Stem Cells And Tissue Engineering In Medicine And Dentistry

Abdollah Ebrahimi[1], Sahar Maleki[2],Elnaz Torabi[3],Masume mohammadi[4],Fatemeh Sohrabpoor[5*]

1. Dentistry student, Member of research committee, Semnan dental faculty, Semnan University of Medical Science, Semnan, Iran. Email: ebrahimi56666@gmail.com
2. Dentistry student, Member of research committee, Semnan dental faculty, Semnan University of Medical Science, Semnan, Iran. Email: saharmlki2001@gmail.com
3. Medical Doctor, Semnan University of Medical Science, Semnan, Iran. Email: elnaztorabie@gmail.com
4. Dentistry student, Member of research committee, Semnan dental faculty, Semnan University of Medical Science, Semnan, Iran. Email: masoumehmohammadi926@yahoo.com
5. Dentistry student, Member of research committee, Semnan dental faculty, Semnan University of Medical Science, Semnan, Iran. *Corresponding Author. Email: fateme.sohrabpoor9797@gmail.com

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Abstract

Introduction:

The field of medicine and dentistry has been able to use stem cells and tissue engineering to regenerate damaged tissues. This article finds the progress, challengesand future prospects.

Stem Cells: Cells that have the ability to differentiate into various body cells are called stem cells. They primarily divided into two categories: embryonic stem cells (ESCs) and adult stem cells (MSCs).

Tissue Engineering:Functional tissue production by combining cells, scaffolds and signaling factors, in such a way that the scaffolds provide: a three-dimensional substrate for cell growth. signaling factors cause: differentiation, cell proliferation, and guide path towardsneeded tissues.

Empirical approaches:Isolation of stem cells, their cultivation, making a scaffold and culturing cell on it.

Results:In tissue engineering, stem cells have a high ability to repair and regenerate tissues, including: cardiac muscle, spinal cord, dental pulp,gingiva, etc.

Current limitations:Rejection by immunity, Improper ability in mastery in scaffold integration, ethical concerns (use of embryonic stem cells).

Conclusion:Tissue engineering has advanced the medical and dental science by damaged tissue regeneration.Thoughthere are various challenges in this regard, butprogress is going ontofindbettersolutions.

Keywords:

stem cells, tissue, scaffold, regeneration

Introduction

The beginning of stem cell research actually dates back to the late 19th century in Germany. A person named Theodore Bowery introduced the concept of stem cells to the scientific community, after that scientists started using blood stem cells to produce blood and research on leukemia, and discovered stem cells. After that, in the 1950s and 1960s, research was conducted on stem cells that had the ability to make blood, and a path was provided for modern research on stem cells that humans have access to today[1,2].

In 1981, scientists succeeded in using isolated embryonic stem cells (ESCs) and adult stem cells. In 2006, they were able to develop mature cells into induced pluripotent stem cells (iPSCs) with scientific programming, thus improved ethical issues[3].In a research that was about CRISPR-Cas9 gene editing technology, they found that not only this way is potential to treat genetic diseases, but also there is a possibility to edit DNA with CRISPR-Cas9 in order to correct pathogenic genetic mutations[4].In a study published in 2023, researchers pinpointed another scientific wonder called organoids, which are actually self-organizing 3D cultures of stem cells that act as real organs that can be used to examine the biology and disease, as well as drug testing, disease understanding, etc. As this science is developing so rapidly, it has the potential to revolutionize medical research[5].

More importantly, researchers succeeded in discovering induced pluripotent stem cells (iPSCs), in order to restore adult cells to a pluripotent state, which are much more accessible than embryonic stem cells. And also regarding the immune system, the risk of their rejection is much less[6,7].

In tissue engineering, with the advances made in the field of biomaterials, researchers have been able to turn scaffolds into a more suitable platform for the growth and differentiation of cells, and with techniques such as 3D printers, more feasible solutions such as regeneration Introduce vascular tissues, skin,etc[8,9].

Tissue engineering and stem cells are very important for medicine and dentistry because they provide the possibility of regeneration of damaged tissues and organs, in such a way that it is able to manage chronic diseases and reducing the need of organ transplantation. Also in dentistry, it can also regenerate teeth periodontium, etc[10,11].

However, there are challenges in this field that researchers could not manage to solvethem until today, including the lack of ability and complete control over the differentiation of stem cells into desired cellstissues organs, etc, as well as the formation of blood vessels in produced tissues. Also due to insufficient blood supply, it is possible to create unwanted tumors and so on[12,13].

In addition, regarding the ethical issues and gaining public trust in the use and acceptance of this method, there are shortcomings[14].

Therefore, this research provides information about the latest research and achievements, biomaterial innovations, as well as ethical and regulatory issues. In addition, it reflects the cases that need wider research for researchers and policy makers in these fields.

Back ground :

Stem Cells:

Stem cells exist in two categories, including: embryonic stem cells (ESCs) and adult stem cells (miniature ASCs), and both categories have the ability to differentiate, so that stem cells Embryos are derived from blastocysts (ASCs), which are very powerful and capable of differentiating into any type of cell. But mature stem cells (ASCs) that can be found in various tissues of the body including: bone marrow, fat, etc., are ableto differentiate into bone, fat tissue and cartilage[13,15].

Tissue Engineering :

Tissue engineering creates functional tissues by combining cells, scaffolds and signaling molecules, in whichone of the most important of them are the scaffolds, which are made of collagen or polymer, and are designed to imitate the extracellular matrix. By creating a three-dimensional structure, they provide the substrate for the differentiation and formation of cells[16,17]. Signaling molecules also cause the differentiation and expansion of tissue stem cells with cytokines which is a growth factor. In other words, the scaffolds produced by tissue engineering are of two types, natural and synthetic, such that natural scaffolds are made of collagen and synthetic scaffolds are made of polymer by 3D printing[16,18].

Materials and methods:

This research is a review study that deals with approaches in the field of regenerative medicine and dentistry, with a focus on the use of stem cells and tissue engineering.

Inclusion criteria:

Scientific articles that well informed about the effectiveness and advancement in the field of stem cells, tissue engineering and biomaterial innovations, as well as theirchallenge and problems.

Exclusion criteria:

Articles that were weakly related to our research topic, or had low quality in terms of scientific and structural content.

Experimental approaches in the field of using stem cells and tissue engineering in medicine and dentistry:

Research methods usually follow the following steps:

1. Isolation of cells and their cultivation: stem cells are isolated from the desired source and various methods and modifications are performed on them for reproduction[19].
2. Scaffolding: Scaffolding is made in order to provide tissue growth substrate[16].
3. Cell cultivation: stem cells are cultivated on scaffolds[20].

4. In vivo and in vitro testing: engineered tissues are evaluated in terms of functionality and safety[21].

Results:

A significant potential is the regeneration of body tissues by stem cells[22], some of which are mentioned below, has been the results.

Mesenchymal stem cells (MSCs) in the regeneration of cardiac muscle tissue, embryonic stem cells (small ESCs) in the regeneration and improvement of the function of spinal cord tissues, dental pulp stem cells (DPSCs) in various tissue regeneration[11,23].

Current research limitations:

Challenges that have not been solved until today include:

a: Immune rejection: stimulation of immune responses by allogeneic stem cells, as well as the issue of tumor genesis[24].

b: Scaffold integration: lack of sufficient knowledge and ability to integrate and appropriate vascularization of engineered tissues[25].

c: Ethical concerns: chance of fetal hurt and destruction due to the need ofusing ASCs[26].

Conclusion:

Scientific advances in stem cells and tissue engineering have made it possible to have more efficient methods of repairing and regenerating defective or lost tissues, and have met the basic needs in medical and dental treatments.

Stem cells have a high potential to transform into various types of cells and have been successful in tissue repair and regeneration. Also, tissue engineering has provided a suitable platform for the differentiation, proliferation and growth of stem cells to the target tissues through the production of frameworks and biological materials.

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