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Stem cells an era in dentistry: A review

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Abstract
The future of dentistry will be more of regenerative based, where patients own cells can be used to treat diseases. Stem cells are clonogenic cells which show self-renewal and have the capacity to differentiate into any mature cell type. Stem cell therapy has got a paramount role as a future treatment modality in dentistry especially when it comes to tooth regeneration.

Keywords: stem cells, tooth regeneration

Introduction

The future of dentistry is regenerative based, where patients own cells can be used to treat diseases [1] In the face of extraordinary advances in the prevention, diagnosis, and treatment of human diseases, devastating illnesses such as heart disease, diabetes, cancer, and diseases of the nervous system, such as Parkinson's disease and Alzheimer's disease, continues to deprive people of health, independence, and well-being. Research in human developmental biology has led to the discovery of human stem cells [2].

In 1868, the term "stem cell" for the first time appeared in the works of German biologist Haeckel.[3] Wilson coined the term stem cell [4]. In 1908, Russian histologist, Alexander Maksimov, postulated existence of hematopoietic stem cells at congress of hematologic society in Berlin, wherein the term "stem cell" was proposed for scientific use [5].

Stem cells also known as "progenitor or precursor" cells are primitive cells found in all multi-cellular organisms that are characterized by self-renewal and the capacity to differentiate into any mature cell type [2]. They are defined as clonogenic cells capable of both self-renewal and multi-lineage differentiation [6]. They have the capacity for extensive self-renewal and for originating at least one type of highly differentiated descendant [7].

Stem cells have manifold applications and have contributed to the establishment of regenerative medicine. Regenerative medicine is the process of replacing or regenerating human cells, tissues or organs for therapeutic applications. These stem cells have the awesome potential for regeneration and may be used to replace or repair damaged cells, and have the potential to drastically change the treatment of conditions like cancer, Alzheimer's and Parkinson's disease and even paralysis [8].

There are 2 main types of stem cells – embryonic stem cells and adult stem cells – which are classified according to their origin and differentiation potential [9]. Mesenchymal stem cells (MSCs), a type of the adult stem cells that can be harvested from bone marrow and other sources such as liver, umbilical cord, placenta, adipose tissue, synovial membrane, amniotic fluid and even teeth, have increasingly played a central role in regenerative medicine [10] Their attractiveness is found in their multipotency to differentiate and develop into various types of tissues such as adipose, cartilage, and bone, as well as their promising use in patient-specific gene therapy [7, 11].

Sources of stem cells The oral and maxillofacial region can be treated with stem cells from the sources such as Bone marrow, Adipose tissue or Stem cells from oral and maxillofacial region. Bone marrow stem cells (BMSCs) can be harvested from sternum or iliac crest. It is composed of both hematopoietic stem cells and mesenchymal stem cells (MSCs). The majority of oro-maxillofacial oral structures are formed from mesenchymal cells [1].

Adipose tissue

Adipose derived stem cells (ADSCs) contain a group of pluripotent mesenchymal stem cells that exhibit multilineage differentiation [12].

Stem cells from oral and maxillofacial region

Stem cells from oral and maxillofacial region predominantly contain mesenchymal stem cells. There are different types of dental stem cells such as Dental pulp stem cells (DPSCs), Stem cells from exfoliated deciduous teeth (SHED), Periodontal ligament stem cells (PDLSCs),Stem cells from apical papilla (SCAP) and Dental follicle progenitor cells (DFPCs) [1, 12, 13, 14, 15]

Clinical application of stem cell therapy in the oro-maxillofacial region

The structures of interest in oral and maxillofacial region include the enamel, dentin, dental pulp, cementum, periodontal ligament, craniofacial bones, the temporo mandibular joint, ligaments, skeletal muscles, tendons, skin, subcutaneous soft tissue, and salivary glands.

Regeneration of dentin, pulp [1, 16]

Dental pulp tissue has the regenerative potential to form dentin in response to any injury. Regeneration of the pulp inside the damaged tooth can be the basic clinical application of stem therapy in dentistry. Root canal treatment in a young permanent molar will stop the tooth's continuous maturation process there by leaving thin egg shell like weak tooth that is susceptible to fracture. Hence, Regeneration of pulp with stem cell therapy will be a better option. Stem cells harvested from the pulp of unwanted teeth like third molar can be utilized to regenerate the pulp of severely injured tooth thereby preventing the need for endodontic treatment in adults. Stem cells isolated from dental pulp has a potential to differentiate into osteoblasts and are a good source for bone formation.

Stem cells in periodontal regeneration [1]

Stem cells will be a promising tool for regenerating the periodontal structures such as periodontal ligament and other supporting elements.

Regeneration of craniofacial defects [1]

Stem cells can be useful in the regeneration of bone and to correct large craniofacial defects due to cyst enucleation, tumor resection, and trauma.

Dental stem cell advantages

1. Have high plasticity.
2. It can be cryopreserved for longer period (Ideal for stem cell banking).
3. It showed good interaction with scaffold and growth factors.
4. Stem cells transplantations can cause pathogen transmission and also need immunosuppression, so autologous stem cell source is the best option.
5. Dental pulp stem cells will be better fitting tool due to easy surgical access, the very low morbidity of the anatomical site after the collection of the pulp [17].

Tooth regeneration

The regeneration of adult teeth will be possible in future with the newer advancement in stem cell therapy and tissue engineering. Regenerative procedures would be better fitting and alternative tool in place of dental implants. Epithelial mesenchymal interactions are mandatory in tooth development. "These interactions are characterized by the reciprocal exchange of signals between these two naïve germ layer tissues and result in the emergence of unique terminal phenotypes with their supporting cells" [1].

Tooth regeneration involves three key elements which include Inductive morphogenes, Stem cells and Scaffold

Steps involved in regeneration of tooth are

1. Harvesting and expansion of adult stem cells.
2. Seeding the stem cells into scaffold which provides optimized environment.
3. Cells are instructed with targeted soluble molecular signals spatially.
4. Confirming the gene expression profile of the cells for next stage in odontogenesis [1, 18, 19, 20, 21].

Stem cells of dental origin have multiple applications nevertheless there are certain limitations as well. The oncogenic potential of these cells is still to be determined in long-term clinical studies. Moreover, the research is mainly confined to animal models and their extensive clinical application is yet to be tested. Other major limitations are the difficulty to identify, isolate, purify and grow these cells consistently in labs. Immune rejection is also one of the issues, which require a thorough consideration; nevertheless use of autologous cells can overcome this. Lastly, stem/progenitor cells are comparatively less potent than embryonic stem cells. Teeth-like structures cannot replace actual teeth, thus a considerable research research and development efforts is required to advance the dental regenerative therapeutics. Researchers still need to grow blood and nerve supply of teeth to make them fully functional. Although not currently available, these approaches may one day be used as biological alternatives to the synthetic materials currently used [22, 23].

Hence, Dental stem cells have many advantages, and results to date suggest that teeth are a viable source of adult mesenchymal stem cells for a wide range of clinical applications. Ultimately, the use of these dental stem cells

over other sources of mesenchymal stem cells for therapeutic use will not only depend on ease of use and accessibility, but also on the efficiency and quality of repair in relation to cost [24].

Human tooth embryogenesis is approximately eight times slower, and postnatal development lasts several years. Thus, whereas growth, implantation and eruption of bioengineered mouse teeth might take a few weeks, the equivalent time to create a functional human tooth might be many months or even years. Research thus needs to be done to investigate ways of possibly accelerating human tooth development [24]. Like other powerful technologies, dental stem cell research poses challenges as well as risks. If we are to realize the benefits, meet the challenges, and avoid the risks, stem cell research must be conducted under effective, accountable systems of socialresponsible oversight and control, at both the national and international levels [22, 23].

Conclusion

In recent years, the field of dentistry has embossed its presence by taking major leaps in research and further bringing it into practice. The most valuable ongoing research in regenerative dentistry is the study on stem cells. It was instituted that stem cells grow rapidly and have the potential to cause tooth regeneration.

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