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Stem Cells - A Potential Advancement in Dentistry (A Review)

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ABSTRACT:

Dental stem cells (DSCs) have potential for self-renewal and pluripotency. Practical, easy to assemble and inexpensive, DSCs promise high therapeutic potential. The purpose of this review article is to initiate a discussion on the basic information of stem cells, the different stem cells in dentistry, the approaches, the collection and preservation of dental stem cells, and the current status of their application in dentistry. It is often used to correct hidden defects or deformities resulting from injury, disease, or surgery. They can be used for various purposes such as soft tissue bioengineering, pulp, apical tissue, bone, periodontal and temporomandibular joints.

***Keywords*:** Dental stem cells, applications, regeneration

INTRODUCTION

Dental stem cells (DSCs) have potential for self-renewal and pluripotency. These cells can differentiate into mesoderm, endoderm and ectoderm. DSCs exhibit immunomodulatory properties through the release of immune receptors2 and cytokines, and thus can be used to treat autoimmunity, inflammation, allergies, and other diseases.

STEM CELLS TYPES

Stem cell can be classified as:

1. Embryonic stem cells: arise from blastocysts and consist of 50-150 cells[1]. Given the right stimuli, they can produce large amounts of certain types of mature cells. They are versatile and versatile. They have plasticity requirements for cell differentiation.

2. Adult Stem Cells: Adult stem cells are easy to isolate and are not subject to the same legal and ethical restrictions as embryonic stem cells. This, combined with the rare frequency of immune rejection and teratoma formation, makes it suitable for use in many clinical settings[2].

3. Mesenchymal stem cell: They are versatile as they are mainly found in the adipose tissue, skin, bone marrow, structures of oral and maxillofacial.

4. Stem cells from adipose tissue: These cells are harvested and isolated by liposuction, liposuction or liposuction[3]. They are readily available and abundant in nature. It has a wide range because it is pluripotent after differentiation.

5. Umbilical cord stem cell: A type of adult stem cell extracted from umbilical cord blood.

6. Amniotic fluid stem cells. Separation of these cells occurs during the amniocentesis genetic screening procedure during pregnancy or at birth.

7. Bone marrow-derived mesenchymal stem cells: A adult stem cells type that are abundant in bone marrow, have high potential, and are widely used in clinical practice.

8. Dental tissue derived stem cells: These are one of the cheapest types of stem cells. They develop from mesenchymal cells and the neural crest during embryogenesis. However, when using tooth-derived stem cells, there are additional steps associated with cell sorting and purification as the cells are heterogeneous and consist of fibroblast-derived progenitor cells in addition to true cells.

DENTAL STEM CELLS:

These can be dental mesenchymal stem cells derived from dental pulp, deciduous teeth, periodontal ligaments and dental follicles, or dental epithelial stem cells derived from continuously growing mammalian incisors and canines.

1. **Dental pulp-derived stem cells (DPSC):** The most common source of this is stem cells extracted from the pulp of permanent teeth. They are pluripotent and express the MSC markers STRO-1, CD44, and CD146[4].

2. **Exfoliated Human Stem Dendritic Cells (SHED):** These are derived from exfoliated teeth and proliferate faster than DPSCs. These express CD146 and STRO-1, glial and neuronal markers such as βIII Tubulin and Nestin MSC markers.

3. **PDLSC (periodontal ligament stem cells):** Derived from isolated human third molar periodontal ligament. Related structures called alveolar bone-periodontal ligament stem cells (aPDLSCs) have a strong affinity for adipocyte and osteocyte production.

4. **Dental Follicle Stem Cells (DFSC):** These are derived from the hair follicles surrounding the human third molar and are versatile. They can differentiate into osteoblasts, adipocytes, and neuroblasts in vitro and into periodontal ligaments in vivo.

5. **Stem Cells from Apical part of Papilla(SCAP):** They are mobile and have great capacity for proliferation and regeneration. Therefore, it is taken from the growing tooth, usually the apex. They include fibroblast-like cells and odontoblasts with MSC markers.

6. Oral mucosal stem cells: Oral epithelial stem cells or gingival stem cells. When used in vitro, it forms a well-exfoliated maxillary mucosa for use in implantation procedures involving oral structures. Gingival stem cells are reprogrammable and pluripotent, making them easy to isolate and abundant.

7. **Human Dental Epithelial Stem Cells (hDESC):** Derived from decaying epithelial layers containing remnants of third molars or Malassez. They express markers of epithelial stem cell such as p75, E-CAM, Bmi-1, and markers of embryonic stem cell such as Nanog and Oct4[5].

8. **Periosteal Stem Cells**: Human periosteal stem cells are multidifferentiable with dentogenic, adipogenic, chondrogenic and myogenic potential both in viva and in vitro. It is used to repair large defects in the orofacial area as it forms the cortical layer of bone[3].

9. **Salivary gland stem cells**: Derived from salivary gland cells that retain the ability to form ducts and acinar cells and to produce mucins and amylases in vitro. Therefore, it can be used for rehabilitation of patients with decreased salivary gland function after radiotherapy.

DENTAL STEM CELL THERAPY

Restoring the function and anatomy of damaged tissue is the main goal of dental stem cell therapy. Root formation regeneration, pulp tissue regeneration, periodontal reconstruction, implantation and reimplantation assistance, root biotechnology, and pulp-dentin composite engineering are the goals of regenerative dentistry. To obtain stem cells, it is necessary to establish appropriate methods of collection, isolation, culture and cloning. One of the most commonly used stem cells is SHED.

DETERMINATION OF DENTAL PULP STEM CELLS

There are four widely used methods for identifying stem cells[1].

1. Fluorescent antibody sorting against cells: Cells can be stained with specific antibody markers and flow cytometry can be used to identify and separate stem cells from mixed cell populations.

2. Selection of immunomagnetic beads.

3. Staining for immunohistology.

4. Physiological and histological criteria including, proliferation, chemotaxis, phenotype, mineralization activity and differentiation.

CHARACTERISTICS OF STEM CELLS

All primate pluripotent stem cells grow into rounded clumps with ill-defined cell boundaries that exhibit alkaline phosphatase activity. Human alkaline phosphatase has four different isoenzymes. Pluripotent cells require a layer of mouse embryonic fibroblast feeder cells for their support. In cells and anything, these requirements could be replaced by members of the cytokine family, but the human ecosystem, human ecosystems, and rhesus monkey cells are not responsible for such life.

APPLICABILITY IN DENTISTRY

Most studies focus on damaged dentin, pulp, resorbed roots, periodontal regeneration, and caries repair. Tissue engineering applications that use gene transfer techniques to manipulate salivary proteins and oral microbial colonization patterns to promote healing of oral wounds and ulcers are promising and feasible.

A. In osseous regeneration:

The recent known mesenchymal stem cells in connective tissue of gingiva is called as gingival mesenchymal stem cells (GMSCS) which can restore the osteogenic potential of middle gingival nodule cells (GMSC) and restore bone with mandibular defects[6].

B. Dental application of nondental stem cells:

Chinese researchers in biology and regenerative medicine reported a method from the urine stem cells to grow teeth. The have generated tooth-like structures in a group of mice that make up up to 30% of the human field. It has the physical properties of the contralateral tooth to the contralateral tooth (one third of the teeth in the human hand). The claimed advantages of this approach were its non-invasive method, low cost, and the use of otherwise wasted (non-embryonic) somatic cells. Interestingly, unlike other stem cells, urine stem cells do not form tumors when implanted in the body. The autologous source of these cells also reduces the risk of rejection.[6.]

C. Pulp regeneration:

Postnatal stem cells and stem cells cultured on external scaffolds can also be used for pulp tissue regeneration.[7] Regenerating cells with the patient's own cells reduces the risk of immune rejection. Bleeding and clots in the root canal are reduced by overuse of the instrument and the irrigation of root canal is done with an antimicrobial agent. Therefore, this approach should be used with caution as cell composition and clot concentration cannot be predicted. Precise targeting of cells to introduce therapeutic proteins into channels and 3D printing of cells for gene therapy are novel approaches that require further investigation.[8] Pulp reperfusion and nerve reinnervation to create new dentin are performed and considered a successful treatment. Various growth factors are used to stimulate the production of enough cells to cover the defect. Bone marrow stem cells exhibit the ability to differentiate into cementum, periodontal ligament, and alveolar bone. Platelet-rich plasma is mixed with long bone-derived MSCs to fill periodontal defects.[2.]

D. Orofacial tissues regeneration:

Prosthetic and functional correction of hard and soft tissues in the orofacial area is necessary after major injuries, bruises, or surgical procedures. Facial muscles can be regenerated with myoblast-seeded collagen containing growth factors and platelet-rich plasma.[3] Long bone grafts using adipose-derived cells are used to correct cranial malformations. These adipocytes can also be used as scaffolds for soft tissue reconstruction.

E. Teeth regeneration:

Replacing missing teeth is a common procedure in which dental implants or bridges are placed in the jawbone.[9] Prenatal and postnatal tooth germs can be used for regeneration, but the use of prenatal tooth germs is recommended as they tend to develop normal tooth structure. Injectable composites or polymers containing periosteal stem cells are used to correct bone defects like bone and TMJ regeneration. Inorganic bone containing bone factor-rich plasma can also be used to cover the defect. Complications at the donor site are minimal, making it one of the ideal techniques for soft and hard tissue reconstruction. Several tooth regenerative methods have been tried and tested.[10] However, the DSCs divide into several lineages and the regenerated tissues may not resemble the original morphology. Currently, there is no embryonic environment that can transform BMSC into tooth germs. Not immunizing has additional drawbacks and important ethical considerations. Therefore, a multi-step approach involving matrix biologists, bioengineers, cell biologists, pharmacologists and nanotechnologists is needed to harness the enormous potential of stem cell therapy and achieve predictable and reliable therapeutic outcomes is required.

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