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Stem Cells – A Ray of Hope in Orthodontics?

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Abstract:- This review article has implications for future stem cell applications in orthodontics. Stem cells are pluripotent cells that have the ability to differentiate into different cell lines and regenerate tissues. It is very important for the orthodontist to know alternative treatment that can be compared to conventional care when needed.

Keywords:- *Stem Cells, Tissue Engineering, Orthodontics, Craniofacial Tissue Regeneration.*

I. INTRODUCTION

Stem cells are cells that can divide continuously and have the ability to differentiate into different cell types.[1] The term "stem cell" was first used by ED Wilson in his classic book "The Cell in Growth and Development". Stem cells have many different meanings. In addition, the classical definition of stem cells has changed with evidence that stem cells are found in adult tissues and have extraordinary phenotypic plasticity (eg, potency). The basic principles of stem cell definition include: (1) The ability to self-replicate or produce at least one daughter cell with cell initiation-like properties; (2) different types; (3) differentiation of tissue or cell type. In vivo functional reconstruction.[1]

Based on Stem cell ability they can be classified as:

- Totipotent: Produces all cell types, including embryonic stem cells (ESC). Pluripotent: Produces all cell types except membranous cells.
- Multipotent: Differentiates into more than one adult stem cell type.
- Unipotent: Produces a single type of cell. [1,3]
- Stem cells are divided into two types:

✓ Embryonic stem cells (ESC): Embryonic stem cells are characterized by their pluripotency, which means that they can form many tissues in the body. As the embryo develops, embryonic stem cells begin to differentiate and mature and lose their capacity during this time. The use of ESC is restricted due to ethical concerns. [2,3]

✓ Adult stem cells: Adult stem cells, also known as adult stem cells or postnatal stem cells, are found in many tissues and organs. Adult stem cells are defined as undifferentiated cells in adult tissues found in the area of each tissue, where they remain dormant in vivo until activated by epigenetic and/or environmental factors such as mechanical, disease, or trauma.[2, 3]

The Stem cell therapy or tissue engineering has emerged into the field of dentistry as well as orthodontics beyond imagination and has the potential to revolutionize the health sciences. Tissue engineering allows not only to replace missing teeth in the mandible, but also to rebuild the dentin-pulp complex, periodontal tissue, induce condylar bone growth in mandibular defects, and repair craniofacial defects.

Dental stem cells are the mesenchymal stem cells, found in the bone marrow.

There are 5 types:

- *Dental pulp stem cells (DPSCs)*
- *Human exfoliated dental stem cells (SHED) and immature dental stem cells from primary teeth;*
- *Periodontal ligament stem cells; (PDLSCs)*
- *Stem cells from the apical; SCAP)*
- *Dental follicle progenitor cells (DFPC)*

➢ *Dental pulp stem cells*

These are found in the mesenchyme and are found in the pulp of permanent teeth, especially our molars. The great thing about DPSCs is that they can regenerate the dentin-pulp-like complex found in human teeth. [6]

➢ *Stem cells derived from exfoliated human teeth*

These are multipotent mesenchymal stem cells found in the pulp of primary teeth. They are separated from the front teeth of children aged 7-8 years. SHED can differentiate into neuron-like cells, odontoblasts, osteoblasts, and adipocytes. Based on research done in mice, they have been shown to be able to form dentin and bone.

➢ *Periodontal Ligament Stem Cells*

These cells are isolated from PDL of extracted roots. Their ability to differentiate into tissues such as cementum and alveolar bone, was discovered by Seo et al. When transplanted into mice, PDLSCs formed cement/periodontal ligament-like structures and contributed to tissue repair. [7]

➢ *Stem cells from the apical*

Stem cells from the apical papilla were discovered by Sonoyama et al. These mesenchymal cells are located in the apical papilla of the root of immature tooth. Third molars are also an important source of SCAP. It differentiates into odontoblasts, adipocytes, and bone cells. Compared to DPSCs, SCAPs differentiate at higher rate into tooth forming cells.

➢ *Dental Follicle Progenitor Cells*

DFSC were isolated from dental follicles of human third molars. These stem cells have the ability to

differentiate into cement oblasts, osteoblasts, adipocytes and neurons.[8]

II. TISSUE ENGINEERING AND ORTHODONTIC TREATMENT

In orthodontics, tissue is manipulated to provide aesthetic and functional harmony between teeth, oral cavity and craniofacial structures. Tissue engineering represents an opportunity and can be a great way to create texture. Stem cell and tissue engineering knowledge will help orthodontists tailor treatment plans.

III. APPLICATIONS OF STEM CELL THERAPY IN ORTHODONTICS

➢ *Dentofacial anomalies*

Dentofacial Anomalies such as congenital and developmental deformities, including traumatic tumor resection and abnormalities due to fracture non-union, are a medical problem and stem cell-based tissue regeneration has been made it easier. Major craniofacial disorders such as cleft lip and palate (CLP) and hemifacial malformation (HFM) can be treated with tissue engineering. In the case of alveolar bone defects in CLP, MSCs have been shown to be able to produce new bone when transplanted into the defect. HFM, another rare soft tissue defect, is frequently encountered with congenital facial deformities due to morphogenetic defects of the first and second pharyngeal arches. The hallmark of HFM is unilateral hypoplasia of the skull and the tissues that cover it. Adipose -derived stromal cells (ASCs) were transplanted into HFM patients showing tissue repair.[6]

➢ *Temporomandibular Joint Disorders*

TMJ is capsulated and lubricated by synovial fluid and is an important growth site during postnatal development. There are injuries, tumors, osteoarthritis, rheumatoid arthritis and congenital abnormalities associated with TMJ. Severe TMJ pain requires mandibular condyle replacement. Studies have shown that MSCs can regenerate osteochondral tissue in the TMJ and also at the joint. [1.6]

➢ *Distraction Osteogenesis*

Distraction Osteogenesis is a method that increases bone length by creating a space between two bone fragments. Stem cells can mobilize osteoblasts and osteoclasts. Recently, stem cell engineering has offered an alternative to traditional DO and eliminated complications of DO such as non-union, infection or bone loss. As noted by many researchers, SHED and MSC have accelerated the process of osteogenesis in the affected area.

➢ *Rapid maxillary expansion*

Maxillary constriction can cause many problems, including occlusal incoordination and aesthetic and functional difficulties, narrowing of the pharyngeal airway, tongue position change that causes narrowing of the retroglossal airway and mouth breathing. It is usually treated by one of these methods, ie. Slow orthodontic expansion, rapid maxillary expansion, surgical-assisted rapid maxillary expansion, or two-stage Le Fort I osteotomy with expansion. During maxilla expansion, a cavity filled with blood and granulation tissue forms in the mid palatine suture and expands the maxilla to balance the width between the jaws. Histologically, RME appears to inhibit osteogenesis, in which a cavity filled with blood and connective tissue is replaced by active bone formation. MCSs can be used topically to the expanded maxilla to accelerate new bone formation in the mid palatal suture and reduce treatment and retention time.[4,5]

➢ *Accelerates orthodontic tooth movement*

During orthodontic tooth movement, the PDL and alveolar bone remodel in response to mechanical loads. When force is applied to the tooth, the PDL contracts. There will be inflammation and osteoclast formation at the compression site. Osteoclasts are derived from hematopoietic stem cells. Therefore, stem cells can be used to accelerate OTM by providing progenitor cells.[6]

➢ *Restoration of Alveolar Bone Defects*

During orthodontic extractions, it can cause undesirable alveolar bone defects that need to be repaired to prevent fractures and other problems at the stage after the tooth has been retracted into the extraction site. Risk of periodontal damage. It can be used in the treatment of such fractures. [2]

➢ *External root resorption*

A common problem in orthodontic dentistry. Root resorption is observed, causing loss of cementum and dentin. There is currently no cure. But stem cells and tissue engineering can be used for regeneration. The blade can be extended by adjusting the ERR weight. A study showed that stem cells driven by PDL can form cellular cementum, a tissue containing osteoclast-positive cells.[6,7,8]

IV. SUMMARY

While stem cells are promising for many applications in orthodontics, including tissue regeneration and rapid tooth movement, more research is needed to determine their intended effectiveness and safety before they can be widely used in orthodontic practice.

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