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STEM CELLS IN DENTISTRY AND MEDICINE - A REVIEW

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ABSTRACT

Stem cells are cells that have the ability to continuously divide and produce progeny cells that differentiate into various other types of cells or types of tissues. They are unspecialized and are capable of dividing and renewing themselves. The scope of applications of stem cells in dentistry and medicine is vast and includes continued root formation, in pulp healing and regeneration, in replantation and transplantation, pulp/dentin tissue engineering and regeneration and bioroot engineering and reconstruction of the periodontium, in cancer management and research. The aim of the study was to review the applications of stem cells in various fields of dentistry, with emphasis on its banking, and to understand how dental stem cells can be used for regeneration of oral and non- oral tissues conversely.

Key words: stem cells, dentistry, periodontal regeneration, genetics, medicine.

INTRODUCTION

Stem cells are immature, undifferentiated cells that can divide and multiply for an extended period of time, differentiating into specific types of cells and tissues. They are defined as cells that self- replicate and are able to differentiate into at least two different cell types. Both criteria must be present for a cell to be called a ‘stem cell’ [1]. Discoveries in stem cell research present an opportunity for scientific evidence that stem cells, whether derived from adult tissues or the earliest cellular forms, hold great promise that goes far beyond regenerative medicine. Dentists are at the forefront of engaging their patients in potentially lifesaving therapies derived from their own stem cells located either in deciduous or permanent teeth.

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. mesenchymal stem cells(MSC) play an important role in the field of dentistry as it could help in regeneration of vital structures like bone, cementum, periodontal ligament fibers, and dental pulp. The regeneration of bone is a key issue at the forefront of current tissue engineering applications, owing to the ease of use and accessibility of osteoprogenitor cells [2]. The use of natural and synthetic biomaterials as carriers for MSC delivery has shown increasing promise for orthopaedic therapeutic applications, especially bone formation. Recent advances in the field of biomaterials have led to a transition from non-porous, biologically inert materials to more porous, osteoconductive biomaterials, and, in particular, the use of cell-matrix composites [3].

A number of delivery vehicles have been successfully used in cell-matrix composites in vivo, such as porous ceramics of hydroxyapatite and tricalcium phosphate loaded with autologous MSCs. Several craniofacial structures- such as the mandibular condyle, calvarial bone, cranial suture, and subcutaneous adipose tissue- have been engineered from mesenchymal stem cells, growth factor, and/or gene therapy approaches [4]. Adult mesenchymal stem cells have advantages over

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embryonic stem cells for tissue engineering of the mandibular condyle, because adult mesenchymal stem cells (MSCs) can be obtained from the same individual and readily induced to differentiate into both chondrogenic and osteogenic cells. Biomimetic scaffolds are frequently needed to enable cell growth and differentiation to occur in an environment that has been previously unfamiliar to either biologists or engineers [5].

MSCs have the potential for the regeneration of mammalian dental tissues. Deciduous teeth contain a population of more immature multipotent stem cells, which are capable of forming dentin-like structures but not a complete dentin-pulp complex. The developed bio-engineered tooth had a well-defined pulp chambers, odontoblasts, pre-dentin, and dentin. It also contained a morphologically correct enamel organ consisting of stellate reticulum, stratum intermedium, ameloblasts, and dental enamel. In addition, Hertwig's root sheath epithelia were also present. Dental pulp stem cells were capable of generating a reparative dentin-like structure directly on the surface of human dentin. It has been demonstrated that human PDL contains a population of multipotent post-natal stem cells that can be expanded ex vivo, providing a unique reservoir of stem cells [6].

The progenitor cells of the PDL appear to be morphologically heterogeneous. This confirms observations, both in osteogenic tissue and wounded PDL, that progenitors can synthesize DNA at various stages of their differentiation [7].

Stem Cells in Dentistry

Stem cells and stem cell therapies will emerge to become an important aspect in the everyday practice of dental professionals. It is important for all dentists, dental specialists, hygienists and their auxiliary staff to educate themselves on the basics of stem cell science [8]. Adult stem cells may be used to regenerate bone and correct oral and craniofacial defects. Both in vitro studies and in vivo research in animal models has shown that tooth-derived adult stem cells can be used to regrow tooth roots in the presence of proper growth factors and a biologically compatible "scaffold."Regenerative therapy is less invasive than surgical implantation, and early animal studies suggest comparable results in strength and function of the biological implant as compared to a traditional dental implant. Stem cells extracted from the dental pulp of a third molar could be harvested, then directly implanted into the pulp chamber of a severely injured tooth. The goal is to regenerate the pulp inside the damaged tooth, preventing the need for endodontic treatment. Stem cells derived from the periodontal ligament may offer promise for regenerating the periodontal ligament and other supporting structures of the periodontium that have been destroyed by gingival disease, with an alternative approach to traditional clinical therapies [9]. Tissue-engineered bone grafts will be useful for practitioners in all of the dental specialties. Future tissues may also include engineered TMJ joints and cranial sutures, which would be especially helpful to craniofacial and oral maxillofacial surgeons [10].

Stem Cells in Medicine

Applications of regenerative medicine technology may offer new therapies for patients with injuries, end-stage organ failure, or other clinical problems. Currently, patients with injuries, end-stage organ failure, or other clinical problems [11]. Currently,patients suffering from diseased and injured organs can be treated with transplanted organs. However, there is a shortage of donor organs that is worsening yearly as the population ages and new cases of organ failure increase. Scientists in the field of regenerative medicine and tissue engineering are now applying the principles of cell transplantation, material science, and bioengineering to construct biological substitutes that will restore and maintain normal function in diseased and injured tissues [12]. The stem cell field is a rapidly advancing aspect of regenerative medicine as well, and new discoveries here create new options for this type of therapy. Stem cell-based therapies are being investigated for the treatment of many conditions, including neurodegenerative conditions such as Parkinson's disease and multiple sclerosis, liver disease, diabetes, cardiovascular disease, autoimmune diseases, musculoskeletal disorders, and for nerve regeneration following brain or spinal cord injury [13]. The mesenchymal stem cells found in teeth may be beneficial for the treatment of neurodegenerative diseases and the repair of motor nerves following stroke or injury. This exciting research will lead to future treatment options that allow muscles to repair themselves following injury, such as the muscle damage that occurs after a heart attack, or the structural damage that occurs following a knee injury. As the number of people affected by degenerative diseases continues to increase, there will be a greater need for new treatment options for the ever-growing aging population. Harvesting and storing stem cells now will ensure their availability in the future when they will be needed most.

CONCLUSION

The goal of gene-enhanced periodontal regeneration is to reclaim the lost regenerative capacity within the PDL space. While gene enhanced tissue engineering can be used in conjunction with stem cells, this technique has the greatest potential if it can be adapted for use with easily harvestable fully mature cells (e.g. gingival fibroblasts, periodontal ligament fibroblasts). These cells are then genetically-enhanced to express growth factors that are involved in the initial formation of both dental and periodontal attachment tissues. In short, this approach is intended to mimic the normal biological process that occurs as these tissues are formed early in development. The current research on dental stem cells is expanding at an unprecedented rate. MSC–derived chondrocytes can be used for reconstruction of orofacial cartilage structures such as temporomandibular joint and nasal cartilage. MSC–derived osteoblast can be used for regeneration of oral and craniofacial bones. MSC–derived myocytes can be used to treat muscular dystrophy and facial muscle atrophy. MSC–derived adipocytes have the ability to repair damaged cardiac tissues following a heart attack. It is now possible to cryopreserve healthy teeth as mn sources of autogenous stem cells, either when they are exfoliated or by extraction, because the opportunity to bank a patient's dental stem cells will have the greatest future impact if seized when patients are young and healthy, for future regenerative therapies.

The conservative treatment of life-threatening and disfiguring defects and diseases and the ability to treat currently incurable diseases are becoming a reality. To date, the research is only confined to animal models and more human research trials are needed to determine the therapeutic utility of stem cells. Stem cell costs, coverage by health insurance, and role of pharmaceutical companies, play a pivot role in determining the future of stem cells.

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CONFLICT OF INTEREST:
The authors declare that they have no conflict of interest.

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