REVIEW ARTICLE

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Stem cells in maxillofacial region: Review

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ABSTRACT:

Cells having distinctive capacity for self renewal and potency are called as stem cells. With proper biochemical signals, these cells can be converted to desirable cell types. This article provides a brief review of stem cells, discussing their types, properties and advantages. Emphasis has been given to what role these stem cells have in oral and maxillofacial region including re-establishment of tooth and craniofacial defects.

Keywords: Bone, Exfoliation, Third molar, Totipotency.

INTRODUCTION

Cells which possess the capacity of self renewal and potency are called stem cells. The stem cells undergo mitotic cell division for renewal with maintenance of undifferentiated state of cell.[1,2] Replacement of orofacial structures is quite complicated as it is made up of complex anatomical structures. Stem cells along with growth factors are vital to form these structures.[3,4] Rejuvenation of oral and maxillofacial structures has been made possible by stem cell therapy.

Stems cells are divided into 3 main types:

Embryonic stem cells: They have ability of multipotential differentiation but clinical less feasible due to ethical issues. The inner cell mass of the embryo is used which forms embryonic cell lines.[5,6] These stem cells differentiate into any of the three germ layers.[7] Tumorigenesis and immune rejection is frequent with embryonic stem cells.

Adult stem cells: They are collected from various kinds of tissues including amniotic fluid, dental pulp, bone marrow, umbilical cord, adipose tissue. It is simple to isolate them, without any ethical issues. Further complications are also less with adult stem cells. These are commonly used in present day practice.[4]

Induced pluripotent stem cell (IPS): It is an emerging idea, with the help of vectors; few genes present in stem cells are inserted into the donor cells. The stem cells so produced by this have properties similar to embryonic stem cells.[5]

SOURCES OF STEM CELLS:

Bone marrow

Bone marrow stem cells (BMSCs) are produced from iliac crest or sternum and consist of both the hematopoietic and mesenchymal stem cells (MSCs).[8] The advantage of bone marrow is having large volume of stem cells.[9]

Adipose tissue

They may be harvested from the liposuction aspirate. Adipose derived stem cells (ADSCs) are a group of pleuripotent mesenchymal stem cells which show multilineage differentiation.[10] Advantage of adipose tissue is that it is easily available and ample in many individuals.

Stem cells from the oral and maxillofacial region

Stem cells from oral and maxillofacial region chiefly contain mesenchymal stem cells. These are categorized as: Figure 1

- Dental pulp stem cells (DPSCs)
- Stem cells from exfoliated deciduous teeth (SHED)
- Periodontal ligament stem cells (PDLSCs)
- Stem cells from apical papilla (SCAP)
- Dental follicle progenitor cells (DFPCs)

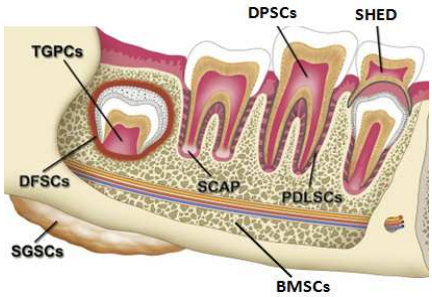

Figure 1: Diagrammatic representation of various dental stem cells

The dental stem cells also have a potential of self renewal and differentiation.

Advantages of dental stem cells:

1. High plasticity
2. Cryopreservation
3. Easy accessibility and very low morbidity of anatomical site after pulp retrieval

Clinical application of stem cell therapy in oral and maxillofacial region

The structures of significance in oral and maxillofacial region consist of the enamel, dentin- pulp complex, cementum and periodontal ligament with facial bones, Temporomandibular joint and salivary glands.

Regeneration of dentin and pulp

Dental pulp has the potential to form dentin in response to an injury.

The essential clinical application of stem cell therapy in dentistry could be regeneration of the pulp within the damaged tooth. Root canal treatment in a young permanent molar stops the tooth's continuous maturation process, thus leaving a weak tooth susceptible to fracture. Stem cells extracted from pulp of any unwanted tooth can be utilized to rejuvenate the pulp of an injured tooth thereby avoiding endodontic treatment in patients.[10]

Role in periodontal regeneration

Stem cell is a promising means for regenerating the periodontal structures like periodontal ligament and other supporting structures. BMSCs have the capacity of producing alveolar bone, periodontal ligament, hence, providing a substitute for the management of periodontal diseases. Autologous mesenchymal stem cells from iliac crest along with platelet rich plasma has been used for periodontal regeneration. It has also shown good healing and regeneration of interdental papilla.

Iwata et al. harvested and extended primary canine PDL cells in vitro. The transplantable constructs with porous bTCP(b –tricalcium phosphate) can lead to regeneration of periodontal structures, like cementum, bone and periodontal ligament fibers.[11]

Regeneration of craniofacial defects

Stem cells are valuable in the renewal of bone and correction of large craniofacial defects due to trauma, cyst enucleation or tumor resection. The bone defect closure is by transfer of tissue, having the disadvantage of donor site morbidity, not able to restore the function of lost part, accompanied by infection and scarring. Autologous adipose stem cells were harvested from gluteal region with iliac crest bone graft in 7 years old girl with head injury. To keep the cells in place, autologous fibrin glue was prepared by cryoprecipitation. Soft tissue reconstruction is of importance in the oral and maxillofacial region when there is significant loss of soft tissues during trauma or surgery.

Dental pulp Stem cells have a potential to form osteoblasts and are good source of bone formation. Stem cells from oral and

maxillofacial region along with bone marrow stem cells can correct larger defects.

Future tissues

Bone grafts and joints can be produced using stem cells. Stem cell and molecular biologists, and clinicians who have the knowledge of orofacial region can be of help in developing the field of craniofacial tissue engineering. The ability to form a viable bone has a potential for reconstruction of maxillofacial trauma or birth defects and cancer surgeries.[12] Condyle shaped scaffolds were prepared by decellularized bone with help of digitized clinical images. Stem cells were seeded in scaffold, followed by placing in bioreactor chamber which contained culture medium.[13]

Tooth regeneration

The regeneration of adult teeth will be possible with the latest developments in stem cell therapy and tissue engineering in near future. Regenerative procedures would be used as substitute for dental implants. For tooth development to occur an interaction between epithelial mesenchymal components is important. "This involves equal switch of signals between the two germ layers producing unique phenotypes".[14]

For regeneration of tooth, three major factors like inductive morphogenes, stem cells and a scaffold are needed.

Steps implicated in tooth regeneration are:

1. Production and growth of adult stem cells.
2. Seeding of stem cells in the scaffold.
3. Cells are inculcated with targeted soluble molecular signals spatially.
4. Validating the gene expression profile of the cells for the next stage in odontogenesis.[15,16]

CONCLUSION

The future dentistry will be more of rejuvenating type where autologous cells of patient can be used to treat his diseases. Regenerative dentistry should be in pace with regenerative medicine. Stem cells should be differentiated to the suitable cell types before they are used clinically, otherwise deleterious effects will result. Local conditions like type of scaffold and the presence of any microorganism should be very carefully analyzed. Extended patient follow up is required to study the life time of regenerated tissue.

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