MINI REVIEW

Dental Pulp Stem Cells (DPSCs) vs. Stem cells from Apical Papilla (SCAP).

Mamatha GS Reddy[1], Gayatri Nayanar[2].

Abstract

Introduction: Mesenchymal stem cells (MSCs) are the adult stem cells with potential to differentiate into various tissues. Like in other tissues, MSCs also reside in dental pulp after toot development and help in repair and regeneration by differentiating into odontoblasts. Dental Pulp Stem Cells (DPSCs) and Stem cells from Apical Papilla (SCAP) are the type of MSCs from dental papilla and apical papilla respectively.

Aim: The aim of this paper is to highlight the characteristics of DPSCs and SCAP.

Method: Information was obtained and compiled from published literature and electronic database search engine from PubMed and Google Scholar.

Results: In spite of both DPSCs and SCAP having similar cell population origin they possess some different characteristics. Conclusion: The Dental stem cells with different characteristics of similar origin can be utilized in the stem cell based tissue engineering.

Key Words: Dental Pulp Stem Cells; mesenchymal stem cells; regeneration; repair stem cells from apical papilla.

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Introduction

The recent years have witnessed advances in the research of mesenchymal stem cells (MSCs) owing to its unique cell biology and diverse clinical potential. These adult stem cells are endowed with abilities like self-renewal, multi-lineage differentiation and low immunogenicity making them an interesting resource that can pave way for future research in the area of tissue engineering and regeneration.[1] The current research in the field of dentistry too has utilized these cells resource for various innovative therapeutic and clinical strategies. MSCs from different tissues have been used for dental tissue regeneration include bone marrow, adipose tissues, umbilical cord blood and dental tissues.1 Dental pulp stem cells (DPSCs)are the first of its kind stem cells isolated from dental tissues followed by others isolated from exfoliated deciduous teeth, periodontal ligament, gingiva, alveolar bone and dental follicle.[2] Of lately, stem cells from apical papilla (SCAP) have also intrigued researchers with their novel characteristics. MSCs derived from apical papilla region have the capacity to form the root.[3,4] Besides, Hertwig's epithelial root sheath and follicular tissues also present as a single entity are together known as developing apical complex. Since SCAPs and DFPCs (Dental follicle progenitor cells) both arise from the developing apical complex, they are also termed as developing apical complex cells (DACCs).[5]

Dental tissue derived stem cells (DSCs)have expressed potential for multidiferentiation into various cell lineage atleast into three of them which includes osteo/odontogenic, adipogenic, and neurogenic.[6] Although these different dental tissue stem cells possess similar characteristics, they do exhibit heterogeneity as a result of their phenotypic differences which may lead to some extent of functional discrepancies.[1] This review has mainly comparatively analysed the cell attributes of the dental tissue derived stem cells, DPSCs and SCAP.

[1.] Department of Oral Pathology and Microbiology, Dr. D. Y. Patil Vidyapeeth's, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune-18; [2.] Graduate School of Medicine and Dental Sciences, Tokyo Medical and Dental University, Japan.

Corresponding Author: Mamatha GS Reddy, Department of Oral Pathology and Microbiology, Dr. D.Y.Patil Vidyapeeth's, Dr. D.Y.Patil Dental College and Hospital, Pimpri, Pune-18. Email Id:drmamatha78@gmail.com.

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Isolation

Isolation and culture in general poses many challenges and the protocols associated differs for different cell types. DPSCs were first isolated in 2000,[7] followed by isolation from exfoliated deciduous teeth, periodontal ligament and apical papilla.[8,9]

Isolation of DPSCs: The pulp tissue is obtained from the dental chamber after splitting an extracted permanent tooth and then minced in a enzyme solution (mixture of collagenase and dipas-

es) and then digested in the same solution at 37°C for 30–60 min. This is followed by filtration of solution using a cell strainer. The cells released are then plated in a medium enriched with nutritional supplements.[10]

Isolation of SCAP: There are two methods that have been used in isolation of SCAP. a) Enzyme digestion b) Explant culture. The former is more commonly used. It involves separation of the apical papilla tissue from the root tip followed by mincing of the tissue and digestion in an enzymatic mixture of collagenase and dipases. The solution is strained to collect the cells and then seeded on to the culture dishes.

Though the culture methods are similar the isolation procedure for the apical papilla from the root tips is comparatively easier and more convenient compared to the difficult tooth sectioning procedure involved in extraction of pulpal tissue, thereupon making SCAP a more feasible source. However, one should consider the fact that since apical papilla subsequently evolves into dental pulp, SCAP can be isolated only at a specific stage of tooth development.

Phenotypic characterisation

Morphologically, DPSCs represent a spindle-shaped which are narrow to large polygonal cells whereas SCAP are comparatively smaller in size, fibroblast-like or stellate in shape, possessing cytoplasmic extensions called filopodia.[1] As far as their growth characteristics are concerned, though both DPSCs and SCAP are actively involved in odontoblastic differentiation, various studies have demonstrated that SCAP exhibits a significant higher proliferation rate than DPSCs. Moreover the mineralization rate after induction of differentiation and migration abilty of SCAP is also comparatively greater than DPSCs.[1,11]

Studies have reported expression of various surface and intracellular molecular markers on DPSCs and SCAP. DPSCs and SCAP cultures were positive for STRO-1, CD146 and CD34, inbut negative for CD45.[1] Besides, SCAP is also reported to have expressed CD13, CD24, CD29, CD44, CD49, CD51, CD56, CD61, CD73, CD90, CD105, CD106, CD166, NOTCH3, and vimentin while shown negative for CD14, CD18, CD34, CD45, CD117, and CD150. CD24 was found to be differentially expressed by SCAP in relation to DPSCs. Aditionally, SCAP was shown to have higher expression compared to DPSCs, for survivin and telomerase which is also associated with its increased proliferative activity.[11]

The epithelium and mesenchyme of dental tissues have shown presence of various Notch receptors and ligands during different stages of tooth development.[12] Notch signalling is known to significantly affect the functions of dental stem cell during tooth development, repair and homeostasis. Bioinformatics analysis in a study has demonstrated an increased expression of NOTCH3, NOTCH4, DLL1, and HES1 mRNA levels in DPSCs than SCAPs, probably also being the reason for its comparatively decreased proliferative activity than SCAPs.[13]

Odontogenic differentiation and mineralization markers DSPP, BSP, OCN, ALP showed progressive expression with both MSCs, but delayed expression of DSPP was seen with SCAP cultures than DPSCs-cultures. However, since SCAP has been showing a significantly higher proliferation rate and mineralization potential, it might prove significant for their application in bone/dental tissue engineering.[1]

Cytokine Profiles

Cytokines related to odontoblastic differentiation such as NT-3, BMP-4, TGF-β1, TGF-β3,NT-4 and epidermal growth factor receptor were found to be highly expressed in DPSC cultures. In addition, DPSCs have also been shown to strongly express proinflammatory cytokines such as TNF-α and TNF-β.[5] Some studies also reported higher expression of mineralization specific cytokines in DPSCs than DACCs.[5]

On the other hand, DACC cultures demonstrated expression of cytokines of cellular proliferation such as IGF-1 and IGFBF-6 and anti-inflammatory cytokineIL-10. The expression of anti-inflammatory cytokine may probably facilitate osteogenesis and development of tissue in the apical complex.[5] Moreover, as per some authors SCAP cultures also tend to show strong angiogenic potential as with their expression of factors like ANGPT1, EDN1, IGFBP43, uPA, and VEGF.[14] Some studies also reported higher expression of mineralization specific cytokines in DPSCs than DACCs.[5]

Conclusion

Different types of dental MSCs can be utilized as a source of stem cells for cell differentiation and biomineralization for various stem cell-based tissue regeneration.

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