MATHEWS Open Access Journals

ISSN 2474-6843

Editorial | Mathews Journal of Dentistry

The Past and Future of Endodontic Treatments: Where and How we are Going?

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Received Date: 12 Dec 2016

Accepted Date: 12 Dec 2016

Published Date: 13 Dec 2016

Citation: Goldberg M. (2017). The Past and Future of Endodontic Treatments: Where and How we are Going?. M J Dent. 2(1): 012.

INTRODUCTION

Following a pulp exposure, gradual alterations dues to the carious decay were detected in the dental pulp. Small necrotic foci exhibiting limited necrosis were noticeable, and they were growing slowly or rapidly. A sequence of treatment of the infected pulp leads endodontic therapy [1]. Elimination of the infection and the protection of a decontaminated tooth, free from future microbial invasion, implicate the removal of nerve, blood vessels, cell remnants and fibers containing connective tissue. They contribute to direct the shaping, orientation, and enlargement of the root canal, while cleaning of the roots. This is completed by the filling of decontaminated canals with a stable material. Since more than one century, root canal treatments provide good results in the context of endodontic therapies. It was clearly shown that as a consequence of endodontic therapy, pulp healing and regeneration were stimulated inside the root canal. This possibility was linked to the survival of some pulp cells, despite severe pulp alterations.

Inflammatory and immune reactions combine with pulp destruction. The pulp contains cells reacting positively to the carious attack. Inflammatory cells have been characterized. They include dendritic cells, histiocytes/macrophages, T lymphocytes and latent stem cells (progenitors), involved in the stem cells self-renewal [2]. Anti-inflammatory agents include also a series of mediators such as steroids, interleukin-I receptor antagonist, solid tumor necrosis factor (TNF) receptor, IL-10, nitric oxide (NO), heme oxygenase-1 and regulatory T-lymphocytes (Tregs). They play a crucial role by limiting tissue damages. Programmed cell death involves necrosis, apoptosis, nemosis, pyroptosis and autophagy. Proteases are also associated to such processes. They implicate caspases, calpains, cathepsins and transglutaminases. Obviously, reparative dentinogenesis is associated to the expression of class II MHC markers located at the surface of macrophages. These cell markers are involved in the recovery of the wounded root canal, a prerequisite for pulp rescue, leading ultimately to pulp regeneration.

Embryonic stem cells (ECSs) and induced pluripotent cell lines (IPs) provide different tools with a potential for regeneration. However, their phenotype is unstable and the initial phenotype is ultimately restored. In adult teeth, there are a small number of stem cells compared with the total of pulp fibroblasts or pulpoblasts, according to Baume analysis [3]. After isolation, expansion, and characterization of the multipotent human mesenchymal stem cells, 5 to 7 days after the initial plating, committed progenitor cells display a restricted potential. Evaluated by Pittenger et al. [4] as being about 0.001 to 0.01% of the grand total of cells, the subset of undifferentiated cells represents in the dental pulp as little as 1% of the total cell population according to Sloan and Waddington [5]. Side population (SP) cells in human deciduous dental pulp were evaluated to be 2% of the total cells [6]. According to Kenmotsu et al. [7] approximately 0.40% of the pulp cells may be stem cells or side population when they are found in young rats, whereas only 0.11% is found in old rats.

Dental stem cells (DPSCs) have been identified in the pulp. Other stem cells have been isolated from exfoliated deciduous teeth (SHED). Apical papilla stem cells (SCAPs) cells are derived from the apical papilla of growing tooth roots [8]. In vitro, SCAPs exhibit dentinogenic and adipogenic properties. They may also express neuronal, capillaries and pericyte markers.

We have previously reported that in the open apical papilla, some cells have the capacity to multiply, as shown by the Proliferating Cell Nuclear Antigen immunostaining (PCNA labeling). They migrate from the central part of the pulp to the lateral sub-odontoblastic boundaries (Hohl's cells layer). Then, they slide from the root toward the coronal part of the pulp where they underwent terminal differentiation. Asymmetric division of adult stem cells keep the capacity for maintaining multilineage differentiation, cell self-renewal, and stemness.

For a long period of time, pulp lesions were unambiguously directed mechanistically toward endodontic treatments. Nowadays, cell-based pulp therapies open gates on the tissue healing, the future for pulp biological regeneration.

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