# Expanding therapeutic boundaries: Stem cells and tissue engineering

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Over the last decade, research in dentistry has been evolving expressively in the field of tissue engineering. The search for means to achieve tissue repair, or the generation of new tissue, has the goal to broaden dramatically the therapeutic possibilities over different areas. Tissue engineering is a very promising option for providing tissue for craniofacial repair.[5] When added up, the incidence of incisor pre-foramen fissures, which involve the alveolar ridge, and of incisor transforamen fissures, the presence of a full or partial alveolar cleft affects something like 70% of the cleft lip and palate patients.

From an orthodontic therapy point of view, the presence of an alveolar cleft represents the greater management challenge for limiting dental movement in the area adjacent to the cleft. It is paramount to be aware to the constraints imposed by this condition to patients rehabilitation.[1,2,11,12] Aimed at facing this difficulty, the use of secondary alveolar bone graft has been considered the first choice of treatment. Although its efficacy has been largely registered by both literature and clinical practice, this procedure involves complex issues such as cost, general anesthesia, the need for an orthopedic practitioner when the donor site is the iliac crest, morbidity, amongst others. New discoveries have been pointing out towards the development of less invasive and equally efficacious strategies. The American Association of Orthopaedic Surgeons suggests that, given the high demand for grafting procedures, the development and supply of “substitutes for conventional bone grafts” should be a priority. In a recent study,[5] embryonic stem cells have been differentiated into cartilage cells and implanted on artificially created cranial osseous defects. In comparison to the control group, the group that received the implanted tissue had a significantly faster response rate.

Stem cells biology has become an important field of knowledge as a means to understand the tissue regeneration process. It is essential for bioengineering to have a triad comprised of: stem or progenitor cells; a matrix that will serve as a framework for the cells; and signalling proteins, called growth factors, as a booster for cell differentiation.[10] By and large, stem cells present two major features: They have self-renewal capacity and, when multiplying, they may still remain with the features of a stem cell or may differentiate into a wide range of other cell types.[6,7] Dental pulp is actually among the richest tissues in mesenchymal stem cells, which bear a huge application potential for tissue engineering purposes. That happens thanks to the fact that this type of dental tissue is multi-potent and has a high proliferation rate, what makes dental pulp a very valuable source of mesenchymal stem cells to be destined for tissue repair.[3]

In another work, the feasibility of dental pulp from deciduous teeth as an eventual source of stem cells for pulpal tissue engineering has been studied.[4] Mesenchymal stem cells taken

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from the pulp of permanent teeth have already made it possible to develop pulpal tissue, with roughly normal features, over a previously prepared framework.[8] Currently, there is a greater tendency towards using adult stem cells rather than embryonic ones. Some of the reasons that justify this trend are: Adult stem cells involve less complex ethical issues and offer greater control over cell proliferation and differentiation aspects. Embryonic stem cells tend to present disordered and uncontrolled growth, presenting a tumour-like aspect sometimes. This fact may be related to the synergic context and the functional memory of those cells. Cells from embryonic origin are aligned with a development phase when growth and differentiation rates are fairly high if compared to adult stem cells.

Presently, individually created tissues seem to be a more tangible promise within a reasonable time frame.[7] Teeth that underwent external root resorption for orthodontic reasons, for instance, are not likely to recover the tissue loss. That would seem to positively change research evolvement. The apical papilla differs from the dental pulp for containing less cellular and vascular components.[9] However, apical papilla stem cells have shown to have both high repair and differentiation potential. Proof of that may be found in some situations when traumatized and incomplete root formation permanent teeth underwent pulpectomy and subsequent endodontic therapy, and were still able to keep on with the apexification process. These findings open the possibility of using steam cells from apical papilla (SCAP) as well as other types of stem cells for pulp and dentin repair, together with the association between SCAP and periodontal ligament stem cells. This possibility has been called the BIOROOT ENGINEERING.[6]

Tissue development involves the synergy between events and substances in a rather broad and complex spectrum. The ultimate understanding of agents, its functions and the synergic context leads to quite a long way ahead. Nevertheless, results are quite promising and as research methods get enhanced, evolution is just around the corner. A great hurdle still remains in accomplishing the development of periodontal ligament fibers adequately arranged in the interfaces between cement and alveolar bone. Knowledge already provides us a good enough understanding of how to program and stimulate differentiation. However, controlling the location and the amount of growth still remains as a huge obstacle to be overcome. Looking back 15 years, when stem cells research started, and coming to present times, knowledge has been expanding exponentially in this field. But for every new discovery, new ethical dilemmas, questions and challenges also unveil themselves. There is an urgent need for courses of graduation to update their curriculums towards cell biology education, under the light of the current knowledge, as well as for molecular biology. Contemporary orthodontic practitioners should review and deepen their knowledge in those fields. This stands out as a foremost condition to be able to absorb new technologies emerging from bioengineering and extend to patients its significant close coming benefits.

## REFERENCES


1. Abyholm F, Bergland O, Semb G. Secondary bone grafting of alveolar clefts. Scand J Plast Reconstr Surg. 1981;15:127-40.
2. Boyne PJ, Sands NR. Combined orthodontic-surgical management of residual palato-alveolar cleft defects. Am J Orthod. 1976;70(1):20-37.
3. Casagrande L, Cordeiro MM, Nör SA, Nör JE. Dental pulp stem cells in regenerative dentistry. Odontology. 2011;99(1):1-7. Epub 2011 Jan 27.
4. Cordeiro MM, Dong Z, Kaneko T, Zhang Z, Miyazawa M, Shi S, et al. Dental pulp tissue engineering with stem cells from exfoliated deciduous teeth. J Endod. 2008;34(8):962-9.
5. Doan L, Connor K, Heather L, English J, Gomez H, Johnson E, et al. Engineered cartilage heals skull defects. Am J Orthod Dentofacial Orthop. 2010;137(2):162.e1-9.
6. Huang GT, Sonoyama W, Liu Y, Liu H, Wang S, Shi S. The hidden treasure in apical papilla: the potential role in pulp/dentin regeneration and bioroot engineering. J Endod. 2008;34(6):645-51.
7. Huang GT. A paradigm shift in endodontic management of immature teeth: conservation of stem cells for regeneration. J Dent. 2008;36(6):379-86.
8. Sakai VT, Cordeiro MM, Dong Z, Zhang Z, Zeitlin BD, Nör JE. Tooth slice/scaffold model of dental pulp tissue engineering. Adv Dent Res. 2011;23(3):325-32.
9. Sonoyama W, Liu Y, Yamaza T, Tuan RS, Wang S, Shi S, et al. Characterization of the apical papilla and its residing stem cells from human immature permanent teeth: a pilot study. J Endod. 2008;34(2):166-71.
10. Soares AP, Knop LAH, Jesus AA, Araújo TM. Células-tronco em odontologia. Rev Dental Press Ortod Ortop Facial. 2007;12(1):33-40.
11. Stellmach RK. Bone grafting of the alveolus followed by orthopaedic alignment of the alveolar arch in infants with complete CLP. Oral Surg. 1963;16(8):897-912.
12. Turvey TA, Vig K, Moriaty J, Hoke J. Delayed bone grafting in the cleft maxilla and palate. A retrospective multidisciplinary analysis. Am J Orthod. 1984;86(3):244-56.


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