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Editorial

Importance of stem cell therapy in dentistry

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1. Introduction

Modern healthcare has witnessed a major transition from conventional reparative approaches to biologically oriented regenerative strategies. Regenerative medicine emphasizes restoration of tissue structure and function through biological mechanisms rather than artificial replacement. Among these advances, stem cell therapy has emerged as a highly promising modality in dentistry over the past two decades.[1] Traditional dental treatments rely heavily on restorative materials and prosthetic substitutes that replace lost tissues without restoring biological vitality. Stem cell–based therapies, in contrast, aim to regenerate native dental tissues including pulp, dentin, periodontal ligament, alveolar bone, and potentially entire teeth.[2] This regenerative approach has the potential to enhance healing, preserve vitality, and improve long-term treatment outcomes.

2. Understanding Stem Cells

Stem cells are biologically unique cells characterized by their capacity for continuous self-renewal and differentiation into specialized cell types.3³ Based on developmental origin, stem cells are categorized as embryonic stem cells, induced pluripotent stem cells, and adult stem cells. In dental applications, adult mesenchymal stem cells (MSCs) are preferred due to ethical acceptability, clinical safety, and reduced oncogenic risk.[3]

Oral and dental tissues provide abundant and easily accessible sources of MSCs. These include dental pulp stem cells (DPSCs), stem cells from exfoliated deciduous teeth (SHED), periodontal ligament stem cells (PDLSCs), dental follicle stem cells, and stem cells derived from the apical papilla (SCAP).[4] These cell populations demonstrate rapid proliferation and multilineage differentiation capacity, making them particularly suitable for regenerative dental therapies.[6]

3. Stem Cell Therapy in Dental Pulp Regeneration

Regenerative endodontics represents one of the most advanced clinical applications of stem cell therapy in dentistry. Conventional root canal treatment successfully eliminates infection but leaves the tooth non-vital and structurally compromised.[7] Stem cell–based pulp regeneration seeks to re-establish a functional pulp–dentin complex, thereby restoring vascular supply, neural components, and immune defense mechanisms.[7]

Experimental and clinical studies have shown that DPSCs, when combined with appropriate scaffolds and bioactive signaling molecules, can generate pulp-like tissue and stimulate reparative dentinogenesis.[1] This approach is particularly beneficial in immature permanent teeth with incomplete root formation, where stem cell therapy supports continued root development and physiological apical closure.3⁴ Consequently, regenerative endodontic procedures provide a biologically superior alternative to conventional apexification techniques.[7]

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4. Role of Stem Cells in Periodontal Regeneration

Periodontal disease remains a leading cause of tooth loss due to progressive destruction of the supporting periodontal tissues. Conventional periodontal therapies primarily aim to control infection and inflammation, with limited regenerative potential.[9] Stem cell-based periodontal therapy offers a biologically driven strategy to regenerate periodontal ligament, cementum, and alveolar bone.[9]

PDLSCs possess inherent regenerative capabilities due to their origin within the periodontal ligament niche.[3] Preclinical and clinical investigations have demonstrated that transplantation of PDLSCs into periodontal defects results in organized regeneration of periodontal structures.[2] Such regenerative outcomes improve both anatomical integrity and functional tooth support, thereby enhancing long-term periodontal stability.[9]

5. Stem Cell–Mediated Bone Regeneration in Dentistry

Alveolar bone regeneration is a critical requirement in implant dentistry and oral and maxillofacial surgical procedures. Stem cell therapy has shown considerable promise in managing bone deficiencies associated with trauma, pathology, or congenital anomalies.[11] Although autogenous bone grafts remain the gold standard, their use is limited by donor site morbidity and restricted availability.[12]

MSCs derived from dental pulp, bone marrow, and periosteal tissues exhibit strong osteogenic differentiation potential and contribute to new bone formation.[7] When combined with three-dimensional biocompatible scaffolds, these cells enhance bone volume, density, and quality, thereby improving implant osseointegration and long-term success.[11]

6. Applications in Prosthodontics and Implant Dentistry

In prosthodontics, stem cell therapy has introduced biological approaches to improve peri-implant tissue health and implant stability. MSCs facilitate bone regeneration at the implant–bone interface and enhance soft tissue integration around implants.[13] These regenerative effects may reduce implant failure rates, particularly in patients with compromised bone quality or systemic conditions affecting healing.[13]

7. Orthodontic Applications of Stem Cell Therapy

Stem cells play an essential role in orthodontics by regulating alveolar bone remodeling during tooth movement. PDLSCs modulate osteoclastic and osteoblastic activity in response to orthodontic forces.[14] Targeted modulation of stem cell activity has the potential to accelerate orthodontic treatment, reduce root resorption, and improve post-treatment stability.[16]

8. Stem Cell Therapy in Oral Medicine and Oral Pathology

In oral medicine, stem cell-based therapies show promise in the management of oral mucosal defects, salivary gland hypofunction, and radiation-induced xerostomia. Salivary gland stem cells have demonstrated the ability to restore glandular architecture and secretory function following radiation injury.[17] Additionally, stem cell research contributes to regenerative strategies following surgical resection of oral tumors and improves understanding of oral carcinogenesis.[17]

9. Pediatric Dentistry and Craniofacial Regeneration

Stem cell therapy is particularly relevant in pediatric dentistry due to the high regenerative potential of developing dental tissues. SHED exhibit superior proliferative capacity and immunomodulatory properties, making them suitable for pediatric pulp therapy and craniofacial regeneration.19[19] These cells may also contribute to the management of congenital craniofacial anomalies such as cleft lip and palate.[20]

10. Whole Tooth Regeneration: Future Directions

Whole tooth regeneration represents one of the most ambitious objectives of dental regenerative medicine. Experimental studies have demonstrated the formation of tooth-like structures through interactions between epithelial and mesenchymal stem cells.[21] Although clinical translation remains challenging, continued advances in tissue engineering suggest that biological tooth replacement may become feasible in the future.[21]

11. Advantages of Stem Cell Therapy in Dentistry

Stem cell–based therapies offer multiple advantages over conventional dental interventions.[2,6] These include biological regeneration rather than artificial replacement, minimally invasive treatment approaches, improved long-term functional outcomes, reduced dependence on prosthetic materials, and enhanced patient quality of life. Furthermore, dental stem cells can be obtained from routinely discarded tissues such as exfoliated primary teeth and extracted third molars, making them an accessible and sustainable source for regenerative treatments.[4]

12. Challenges and Ethical Considerations

Despite encouraging progress, clinical translation of stem cell therapy in dentistry faces challenges including high costs, technical complexity, lack of standardized protocols, and limited long-term clinical data.[9] Regulatory approval and well-designed randomized clinical trials are essential before widespread clinical implementation.9[10] Ethical concerns are minimal when adult dental stem cells are used, further supporting their translational potential.[3]

13. Conclusion

Stem cell therapy represents a paradigm shift in dentistry by introducing biologically driven regenerative solutions that extend beyond traditional restorative care. Applications across endodontics, periodontology, implant dentistry, orthodontics, pediatric dentistry, and oral medicine highlight the extensive scope of this evolving field.[1,2] Continued scientific research, technological innovation, and clinical validation are essential for integrating stem cell therapy into routine dental practice. As dentistry advances toward patient-centered regenerative care, stem cell therapy is expected to play a pivotal role in shaping the future of oral healthcare.

14. Conflict of Interest

None.

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