Hydrogels in Dentistry: A Comprehensive Review

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ABSTRACT:

Hydrogels are three-dimensional, hydrophilic polymer networks capable of absorbing and retaining significant amounts of water while maintaining structural integrity. Due to their excellent biocompatibility, tunable mechanical properties, biodegradability, and ability to serve as carriers for therapeutic agents, hydrogels have gained immense attention in biomedical sciences, including dentistry. In recent years, hydrogels have emerged as promising materials for drug delivery, wound healing, tissue engineering, bone regeneration, and regenerative endodontics. Their ability to mimic the natural extracellular matrix makes them ideal scaffolds for periodontal, pulpal, and osseous regeneration. Furthermore, advancements in smart hydrogels—such as thermo-responsive, pH-responsive, and photo-crosslinked systems—have expanded their potential in targeted and sustained drug release, implant integration, and minimally invasive treatments.

This comprehensive review discusses the fundamental properties of hydrogels, their classifications, and their diverse clinical applications in dentistry. It also highlights recent technological advancements, current limitations, and future research directions aimed at enhancing their functionality, mechanical strength, and translational potential in clinical dental practice.

KEY WORDS: Hydrogels, Tissue Engineering, Drug Delivery Systems, Regenerative Endodontics, Biomaterials.