COMMENTARY article

Critical aspects and future directions of root canal treatment to know in dental education: A policy brief

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Patients frequently view root canal therapy (RCT) as a frightening and painful dental procedure. However, due to developments in contemporary endodontics, this treatment is now a comparatively more successful and somewhat comfortable technique aimed at preserving natural dentition [1, 2]. Root canal therapy prevents problems like abscess formation and tooth loss by addressing the underlying pathophysiology of pulpal infection and periapical illness rather than only treating symptoms. RCT's function in tooth preservation is one of its noteworthy features. RCT enables patients to keep their natural teeth, improving speech, mastication, and self-confidence, as opposed to extraction, which irreversibly changes oral function and appearance. Moreover, with the addition of full-coverage restorations such as crowns, treated teeth can maintain functionality for many years [3]. To ascertain whether RCT is successful, dental professionals must use the appropriate competence and judgment while assessing endodontic outcomes. After a root-filled tooth has undergone various functional activities throughout time, endodontic success is assessed. Adopting particular criteria is necessary to evaluate such success. Interestingly, several studies have used overlapping criteria [4, 5]. Despite its advantages, RCT is still frequently controversial. Fear of pain or excessive expense causes many patients to hold off on treatment, which frequently results in a worsening infection and systemic effects. Patient education is essential from a public health standpoint, stressing that untreated oral infections may not stay localized but instead might lead to more serious health issues, including systemic inflammation and cardiovascular difficulties [6, 7]. Treatment accuracy and success rates have increased significantly as a result of technological advancements, including rotary endodontics, apex locators, and three-dimensional imaging. However, patient case selection, aseptic protocol adherence, and practitioner expertise all have a significant impact on clinical outcomes. Reinfection and treatment failure highlight the need for ongoing refinement in techniques and patient compliance with follow-up care.

Although there have been significant breakthroughs in RCT in recent decades, problems such as reinfection, insufficient disinfection, and restoration failures still exist. Numerous exciting avenues for the future are being explored to further enhance patient outcomes and success rates [8]. Research is being done on tissue engineering scaffolds, growth factors, and stem cell-based treatments to help the pulp-dentin complex regain its natural function and vitality. Bioactive and antibacterial nanoparticles can improve canal sealing and disinfection. Real-time treatment planning and accurate canal mapping may be made possible by diagnostics powered by artificial intelligence (AI) and cone-beam computed tomography (CBCT) [9, 10]. Trends are moving toward preserving maximum tooth structure through ultraconservative access cavities and selective

canal instrumentation. Combined with improved irrigation systems (e.g., sonic, ultrasonic, or laser-assisted), this approach reduces structural weakening. By using genetic and microbiome analysis, dentists may be able to customize material selection and disinfection procedures according to the risk factors of each patient [11, 12].

Most research on RCT focuses on instrumentation, materials, or pain management. But there are several less-explored or emerging topics that could open new research directions. The majority of researches concentrates on getting rid of infections, but they hardly ever talk about how the balance of the oral microbiota changes following RCT [13]. There is currently little information on the effects of RCT on systemic health and the oral microbial environment. There is not enough research on the connections between unsuccessful RCTs and systemic illnesses such as autoimmune disorders and cardiovascular disease. Investigating root canal infections as sources of systemic inflammation may yield novel therapeutic understandings. While sealing materials are well studied initially, little is known about their long-term interaction with dentin, pulp remnants, and host immunity. Research on microleakage and biodegradation over decades is rare. Although dental anxiety associated with root canal therapy is widespread, little is known about the psychological effects of patient anxiety, pain perception, and compliance. There are not many studies on communication techniques and behavioral interventions. Little research has been done on how environmental pollutants, fluoride, or heavy metals affect pulp vitality and root canal healing. While regenerative techniques are studied experimentally, clinical translation and long-term outcomes are still poorly understood. Ethical and cost-related barriers remain less explored. The goal of dental education is to give students the professional competencies, knowledge, and abilities needed to deliver complete oral healthcare. Root canal therapy, also known as endodontic treatment, is an essential component of the vast array of clinical taught of treatments taught in dentistry schools. In order to preserve oral function and avoid tooth extraction, this treatment is frequently the only way to salvage teeth that have irreparable pulpitis or pulp infections. RCT is a cornerstone of dental education, blending science, art, and clinical judgment. Training in RCT equips future dentists with the ability to preserve natural teeth, relieve pain, and improve patients' quality of life. As dentistry continues to advance, the integration of modern technologies and innovative teaching methods will further strengthen the competence of dental graduates in providing high-quality endodontic care. The future of root canal therapy lies in merging biology, technology, and materials science to move beyond conventional treatment. Regeneration, nanotechnology, AI integration, and biomimetic approaches have the potential to transform RCT from a reparative procedure into a truly restorative and regenerative therapy that preserves tooth structure and vitality. Less-explored areas could help expand root canal research beyond conventional mechanical and chemical methods into patient-centered, systemic, and environmental perspectives.

Conclusion: Root canal treatment should not be seen as a procedure of last resort, but rather as a cornerstone of conservative dentistry. Promoting awareness of its safety, efficacy, and role in long-term oral health preservation is essential in both clinical practice and patient education.

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