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Endodontics at a Crossroads: From Technological Innovation to Clinically Meaningful Progress

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Endodontics is advancing rapidly, driven by innovations in biomaterials, imaging, instrumentation, irrigation, artificial intelligence (AI), and biologically based therapies. Yet this growing technical sophistication raises a fundamental question: what constitutes genuine progress in endodontic care? An instrument may improve procedural precision without improving healing; a treatment may preserve living tissue without necessarily prolonging tooth survival; and an algorithm may achieve high diagnostic accuracy without improving clinical decision-making. These distinctions do not diminish the value of innovation. Rather, they challenge us to assess its significance beyond technical performance.

Recent editorials have questioned the reliance on surrogate endpoints and emphasised the need for stronger clinical evidence to support emerging technologies [1, 2]. Building on these perspectives, we propose that progress in endodontics should be evaluated across five interconnected dimensions: technical performance, biological validity, clinical effectiveness, patient value, and evidence credibility. These dimensions address what an intervention can achieve, whether it is biologically justified, how reliably it improves clinical outcomes, what benefits it offers patients, and how confidently its effects can be established. This conceptual framework is neither a validated scoring system nor a rigid hierarchy. Rather, it encourages conclusions proportionate to the available evidence, while recognising that technical, biological, and patient-centred benefits do not necessarily coincide.

Vital pulp therapy (VPT) illustrates this approach. Its significance lies in preserving viable native pulp tissue when disease control and favourable clinical outcomes remain achievable. The European Society of Endodontology has provided a biological framework for managing deep caries and the exposed pulp [3]. Nevertheless, pulp vitality, structural preservation, biological healing, long-term clinical outcomes, and tooth retention are distinct endpoints and should not be treated as interchangeable.

Clinical investigations increasingly support VPT as a biologically sound and clinically effective approach to preserving vital pulp in mature permanent teeth, including teeth presenting with symptoms traditionally associated with irreversible pulpitis. A multicentre randomised trial reported no statistically significant difference in five-year treatment success between VPT and conventional root canal treatment [4]. Another clinical trial examined patient satisfaction and quality of life alongside conventional treatment outcomes [5], while a large retrospective cohort of 1,257 VPT-treated teeth provided complementary evidence on clinical outcomes and prognostic factors [6]. Taken together, these findings support a shift in treatment philosophy: when the pulp remains vital, and its preservation is biologically and clinically feasible, VPT should be actively considered as a tissue-preserving treatment option, rather than regarded merely as an alternative to root canal treatment. This shift also calls for critical reassessment of traditional classifications of pulpal disease [7], particularly the term 'irreversible pulpitis', which does not, in itself, establish the extent of pulpal damage, the tissue's capacity to heal, or the necessity of removing the pulp. A more biologically informed diagnostic framework is therefore needed to guide tissue-preserving treatment decisions. The future of such care also depends on diagnostic precision. A recently proposed staging classification of pulpitis integrates preoperative and intraoperative findings to support more individualised decisions [8]. Its potential value, however, requires prospective validation, including evidence that improved classification leads to better treatment selection or patient outcomes.

Artificial intelligence presents a parallel challenge [9]. Although AI may improve image interpretation, lesion detection, and outcome prediction, algorithmic accuracy does not, by itself, establish clinical utility. Recent critiques have highlighted limited

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clinical relevance, inadequate external validation, and inconsistent reporting in endodontic AI research [10]. The PAISE initiative aims to improve reporting standards [11]. Ultimately, however, the test is whether AI improves clinical decisions, reduces errors, or delivers measurable benefits to patients.

These considerations also apply to irrigation technologies, biomaterials, and clinical techniques. Laboratory investigations and surrogate measures remain indispensable for elucidating biological mechanisms and establishing technical feasibility. For example, ultrastructural investigations have demonstrated neodentinal bridge formation following direct pulp capping with mineral trioxide aggregate (MTA) [12], whereas an experimental study found that adding calcium chloride to MTA did not significantly improve histological pulp responses [13]. Such findings illustrate both the contributions and limitations of experimental research, which should not be interpreted as definitive evidence of clinical superiority. Accordingly, the strength of clinical claims should reflect the maturity and quality of the supporting evidence.

For researchers and journal editors, this principle has practical implications. Studies should distinguish technical endpoints from biological, clinical, and patient-reported outcomes; employ meaningful comparators and appropriate follow-up periods; and report uncertainty and adverse findings transparently. Early-stage research should be judged against its stated objectives, whereas broader claims about clinical benefit should require correspondingly stronger evidence. As the Iranian Endodontic Journal enters a new phase in its scientific development, its commitment to rigorous, clinically relevant, and trustworthy scholarship carries particular responsibility [14, 15]. Beyond disseminating research findings, the journal can help shape the standards by which innovation is evaluated by encouraging methodological transparency, independent validation, and balanced interpretation of emerging evidence. By welcoming well-designed clinical investigations alongside robust experimental and translational studies, and by valuing meaningful research questions over fashionable technologies or selectively positive findings, the journal can foster a research culture in which scientific novelty remains connected to biological understanding, clinical relevance, and patient benefit.

The future of endodontics should not be framed as a choice between technological advancement and biological conservation. Both are essential, provided that their contributions are evaluated with scientific rigour. True progress lies not simply in what new technologies enable us to do, but in what we can demonstrate, with credible evidence, that they achieve for the teeth, tissues, and patients entrusted to our care.

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