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Comparative Analysis of 3D Root Canal Structures Using Micro-CT

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Objectives Dental micro-CT (µCT) provides highly detailed visualization of root canal structures and treatment defects. However, the relationship between root canal morphologies and the outcomes of root canal treatment (RCT) remains insufficiently understood. Therefore, we introduce a data analysis framework that standardizes the representation of root canal anatomy and associated defects. Our aim is to investigate how morphological features of root canals influence RCT outcomes, potentially improving future clinical treatment options.
Methods An integrated framework is being developed to segment root canal structures from high-resolution dental µCT datasets using deep learning and represent them in a compact, standardized, and comprehensive manner. The framework enables continuous visualization along the full length of the root canal, allowing spatial mapping of defects such as cracks and pores. Interactive exploration is supported through a linking-and-brushing paradigm, facilitating analysis of relationships between root canal morphologies and defect occurrences. Our framework reduces dimensionality of complex 3D data while preserving key morphological features, thus enabling comparisons and defect analysis across µCT samples.
Results The framework produces a simplified yet information-rich representation of complex volumetric µCT data. Mapping root canal structures along their length reveals spatial patterns of defect occurrences that are difficult to quantify with conventional visualization methods. Interactive exploration further enhances identification of relationships between anatomical configurations and defect distribution, offering new insights into potential causes of treatment failures.
Conclusions This work presents a concept and a prototype data platform for analysing root canal structures and treatment defects at the microscale. The method contributes to a better understanding of complex µCT data by supporting the identification of structural factors influencing treatment outcomes, which may ultimately drive the development of improved clinical procedures, instruments, and materials in endodontics.