Micro-CT Analysis of Apical Anatomy of Vital and Necrotic Teeth

M.R. R. S. Bardauli

1 University of São Paulo, SP, Brazil, Rua Lineu Prestes 2227 CEP – 05508-000

Aims
Root canal treatment is a procedure that requires, beyond the realm of technique, knowledge of the internal anatomy of the root canal, specifically the anatomical apex. Almost all methodologies studied thus far are destructive, laborious, and time-consuming and allow for only one-dimensional measurements. In the present study, we used micro-CT technology to evaluate the anatomical structures of the apical region in vital and necrotic pulp of human permanent teeth.

Method
This ex vivo study investigated the use of high-resolution micro-CT (SkyScan 1172, SkyScan, Kontich, Belgium), with 6.7-μm pixel resolution, to evaluate 3D slices of apical anatomy of vital (n = 21) (VP) and necrotic (n = 20) (NP) pulp teeth. The x-ray tube was operated at 100 kV, 10 W, and 100 μA, with a 0.5-mm aluminum filter and a focal spot size of 5 μm. Scanning of the specimen was done with a 180° vertical axis rotation, and a single rotation step of 0.9°. The teeth were fit with the crown positioned downward and the long axis perpendicular to the floor of the specimen-holder and the x-ray source. The scanning time for each sample was approximately 45 min. With NRecon volumetric reconstruction software (SkyScan, 1.4.0), acquired angular projections produced two-dimensional cross-sectional slices through the root apical third volume of interest. An automatic filter for beam-hardening compensation during reconstruction was used at a level of 40% and ring correction of 18%, lasting 20 min. The reconstructed set of slices was viewed with the DataViewer software program (SkyScan 1.3.2). Images were displayed as 3 orthogonal sections, centered at the root canal inside the reconstructed axial slice. Then, using the ‘click and drag’ feature to control the 3 intersecting orthogonal sections, we set the images so that the emergence of the open foramen could be seen independently or jointly in both sagittal and coronal sections.

The following data regarding the root apex were measured in sagittal and coronal sections: the cementum extension into both sides of the root canal, and diameters of the apical foramen and root canal at the cemento-dentino canal junction (CDJ) (Figure 1). Two calibrated examiners performed the measurements and additional features could be used, including magnification and gray scale. The inter-examiners agreement was confirmed by intraclass coefficient (ICC) and measurements were compared by Mann-Whitney test (Wilcoxon rank sum test - p≤0.05).

Results
The results indicated that there was no statistically significant difference in relation to the extension of cementum into the root canal in both groups VP or NP with average distances of 0.32±0.1mm and 0.36±0.16mm respectively. The widest diameter of the apical foramen corresponded to the NP group, of 660.53±131.78µm on average. The average diameter of the root at the CDJ was 330.37±126.62µm for VP and 357.62 ±96.14µm for NP groups presenting no statistically significant difference.
**Conclusion**

With Micro-CT, we were able to map the structures and architecture of the root apex. The high-resolution images could differentiate dentinal and cemental tissues. Radiographically, such differentiation could be assessed from the distinct radiopacities and morphological deposition characteristics of the tissues. The results of this study suggested that CDJ position was not influenced by pulp vitality.

**References:**

