Irrigation of human prepared root canal ? ex vivo based computational fluid dynamics analysis

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Aim: To analyze the influence of the needle type, insertion depth, and irrigant flow rate on irrigant flow pattern, flow velocity, and apical pressure by ex-vivo based endodontic irrigation computational fluid dynamics (CFD) analysis.

Methods: Human upper canine root canal was prepared using rotary files. Contrast fluid was introduced in the root canal and scanned by computed tomography (CT) providing a three-dimensional object that was exported to the computer-assisted design (CAD) software. Two probe points were established in the apical portion of the root canal model for flow velocity and pressure measurement.Three different CAD models of 27G irrigation needles (closed-end side-vented, notched open-end, and bevel open-end) were created and placed at 25, 50, 75, and 95% of the working length (WL). Flow rates of 0.05, 0.1, 0.2, 0.3, and 0.4 mL/s were simulated. A total of 60 irrigation simulations were performed by CFD fluid flow solver.

Results: Closed-end side-vented needle required insertion depth closer to WL, regarding efficient irrigant replacement, compared to open-end irrigation needle types,which besides increased velocity produced increased irrigant apical pressure. For all irrigation needle types and needle insertion depths, the increase of flow rate was followed by an increased irrigant apical pressure.

Conclusions: The human root canal shape obtained by CT is applicable in the CFD analysis of endodontic irrigation. All the analyzed values ?irrigant flow pattern, velocity, and pressure ? were influenced by irrigation needle type, as
well as needle insertion depth and irrigant flow rate.

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