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Influence of needle design and irrigation depth in the presence of vapor lock: A computational fluid dynamics analysis in human oval roots with apical ramification

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Abstract-

This paper aims to study the removal of a vapor lock located in the apical ramification of an oval distal root of a human mandibular molar, simulating different needles and irrigation depths with computational fluid dynamic. A geometric reconstruction of the micro-CT of the molar shaped up to a WaveOne Gold Medium instrument was used. A vapor lock located in the apical 2 mm was incorporated. Geometries with positive pressure needles (side-vented [SV], flat or front-vented [FV] and notched [N]) and the EndoVac microcannula (MiC) were created to run the simulations. Irrigation key parameters (flow pattern, irrigant velocity, apical pressure, wall shear stress) and vapor lock removal were compared among the different simulations. Each needle behaved differently that is, FV removed the vapor lock from one ramification and had the highest apical pressure and shear stress values; SV removed the vapor lock in the main root canal but not in the ramification and reached the lowest apical pressure from the positive pressure needles; N was not able to completely remove the vapor lock and showed low apical pressure and shear stress; MiC removed the vapor lock from one ramification, had negative apical pressure and the lowest maximum shear stress. The main conclusion is that none of the needles showed complete removal of vapor lock. MiC, N, and FV were able to partially remove the vapor lock from one out of the three ramifications. However, SV needle was the only simulation that showed high shear stress with low apical pressure.

Index Terms- apical delta, computational fluid dynamics, microCT, negative pressure irrigation, positive pressure irrigation, vapor lock

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