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CFD analysis on the effect of combining positive and negative pressure during the irrigation of artificial isthmuses

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Abstract-

Fluid dynamics generated by irrigation needles have not been deeply analyzed in root canal irregularities such as apical ramifications or isthmus where the cleaning capacity of irrigants might be compromised and hence the treatment outcome. The goal of this study was to compare the key irrigation parameters (flow pattern, irrigant velocity, apical pressure, and shear stress) between two irrigation needles and the additional effect of aspiration cannulas through computational fluid dynamics. A 3D-model consisting of two canals linked by an isthmus was modeled. The abovementioned needles irrigated the primary canal, whereas an aspiration cannula was located inside the secondary canal. Both the geometry definition and spatial discretization were carried out with ANSYS 16.2, through which six different simulations were performed: lateral exit (LE) needle, frontal exit (FE) needle, LE and cannula in crown (LEC), FE and cannula in crown (FEC), LE and cannula in middle third (LEM), FE and cannula in middle third (FEM). FE and FEM showed that the irrigation flow only passes through the isthmus in the most apical section (maximum irrigant velocity / shear stress = 8.44 m/s / 1628.44 Pa and 8.63 m/s / 1185.69 Pa, respectively). However, the remaining simulations showed the irrigation flow passing through the isthmus twice, through the most apical section first and through the upper part of the isthmus later (maximum irrigant velocity / shear stress = 8.48 m/s / 1298.24 Pa (LE), 8.61 m/s / 1261.36 Pa (LEM), 8.61 m/s / 1355.24 Pa (LEC), 8.59 m/s / 1256.87 Pa (FEC)). Furthermore, the highest velocity values were detected when aspiration cannulas were added.

Index Terms- aspiration cannula, CFD, endodontics, irrigation, needle

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