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Evaluation of apical canal shapes produced sequentially during instrumentation with stainless steel hand and Ni-Ti rotary instruments using micro-computed tomography

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I. Objectives

Endodontic success depends on thoroughly cleaned and completely obturated root canal system. Effective cleaning and obturation will be achieved by well shaped canal. Numerous methodologies evaluating the efficacy and safety of canal preparation has been developed and the use of micro-computed tomography(MCT) in endodontic research is one of the latest innovations. This scientific tools could overcome the inherent limitations of other methodologies, and possesses the ability to visualize morphological characteristics in a detailed and accurate manner without destruction of the tooth and offers reproducible data in all three dimensions.

The purpose of this study was to determine the optimal master apical file size with less transportation and more efficiency in removing the infected dentin. For this purpose we evaluated the transportation of canal center and change of untouched area after preparation sequentially from #25 file through #40 file with 3 different instruments; Stainless steel(SS) K-type hand instruments(MANI, Japan), ProFile.04 instrumetns (Dentply Tulsa Dental, USA) and Lightspeed instruments(Lightspeed Technology, San Antonio, USA) using micro-computed tomography.

II. Materials and methods

Thirty extracted human mandibular molars were collected. Each mesial canal had a separate orifice and an apical foramen. All teeth with abrupt canal curvatures and defect of the crown were excluded and their canal curvatures were over 10 degree by Schneider method. They were carefully divided into three groups with evenly distributed canal curvature: Group 1, SS K-files ; Group 2, ProFile .04.;group 3, Light speed. Distal roots were removed and only mesial roots were embedded with self curing resin and custom made resin molds. The teeth were then scanned using MCT(Skys1072, Skyscan b.v.b.a.,Aartselaar, Belgium). After the initial scan, access cavity preparation was done with #4 round bur and the working length recorded as 0.5mm short of the length that a #15 stainless steel file was visualized at the apical constriction. Coronal part of the root was prepared using Gates glidden burs with crown down method from #4 through #2.

The canals were instrumented using corresponding instruments from #20 through #40 to the working length. After preparation with #25 file the second scan was done. And after each preparation step with #30, #35, #40 files, MCT scan was done. So, total five scanning procedures were done with each specimen.

After preparation with each instrument size NaOCl irrigation and patency filing were done in all groups.

Cross-sectional images of the teeth at four different levels:1,2,3,5mm from the apex, were used to evaluate canal transportation and untouched area. The transportation of canal spaces was evaluated by following two methods. One is the distance between original center of the canal and transported center. The other measurement was the angle between original center of the canal and deviated cente after the sequential preparation. Finally we measured the untouched area. Data was statistically analyzed according " Repeated nested design" and corresponding statistics using SPSS program to evaluate the transportation of canal center after

sequential preparation . And Mann-Whitney test was used to evaluate the statistical significance between the two different groups

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III. Conclusions

1. In SS K-file group, there was statistically significant deviation of canal center after preparation with #30 and #35 instruments at 1mm level.($P<0.05$). At 2mm level, the canal center significantly transported after preparation with #40 instrument ($p<0.05$). But removal of untouched area was not increased significantly comparing with smaller preparation size at all level ($p>0.05$).
2. At 1,2mm level, canal transportation were significantly increased after preparation with #40 Profile .04 instrument ($p<0.05$), and untouched areas were decreased after #35 size ($p<0.05$).
3. In SS K-file and Profile groups, statistically significant canal transportation or changes of untouched area were not observed at 3,5mm level ($p>0.05$).
4. In Lightspeed group, canal transportation did not increase abruptly and removal of untouched area increased gradually ($p>0.05$).
5. Directions of canal deviation were randomly distributed.