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Assessment of impact of root canal curvature on the accuracy of an electronic apex locator

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Abstract

Background: Working lengths is defined as the distance from a coronal reference point to the point at which canal preparation and filling should terminate. To determine the working length, a number of techniques, including tactile sensation, radiographs, and electronic apex locators are routinely used in clinics. Hence; the present study was conducted for assessing the impact of root canal curvature on the accuracy of an electronic apex locator.

Materials & Methods: A total of 30 freshly extracted mandibular first molars were included in the present study. At approximately at cemento-enamel junction, all the specimens were sectioned with the help of a diamond disk. This was followed by grouping of all the samples broadly into three study groups as follows: Group A: Specimens with mild canal curvature (Less than 20), Group B: Specimens with moderate canal curvature (In between 20 and 36), and Group C: Specimens with severe canal curvature (More than 36). Actual root canal length was determined through a number 10 file. This was named as actual working length (AL). Working length measured by apex locator was termed as Electronic Working Length (EL). All the results were then recorded in Microsoft excel sheet and were analysed by SPSS software.

Results: Mean difference between AL and EL was 0.139 for group A, 0.273 for group B and 0.265 for group C. While comparing statistically, significant results were obtained while comparing in between group A and group B and between Group B and group C respectively. However; while comparing between group A and group C, non-significant results were obtained.

Conclusion: Electronic working length is slight significantly affected with curvature of the root canal. However; when used with higher precision, electronic apex locators can be used regularly in dental practice with higher accuracy.

Keywords: Apex locator, Curved root canal

Introduction

The removal of infected pulp tissue, necrotic material, and microorganisms from the root canal system is essential for endodontic treatment success. This can be achieved only if the length of the root canal is determined accurately^[1, 2]. Working lengths is defined as the distance from a coronal reference point to the point at which canal preparation and filling should terminate. A correct working length is a critical factor for the endodontic success. Failure to determine the proper root canal working length during root canal treatment may compromise the treatment result. To determine the working length, a number of techniques, including tactile sensation, radiographs, and electronic apex locators are routinely used in clinics^[3-5].

Working length (WL) determination is a crucial factor in successful root canal therapy. The apical constriction (AC) is suggested as the end-point of root canal treatment. This anatomical landmark is a point where pulpal and periodontal tissues reach together and is identified as minor apical foramen. It is generally accepted to be located at 0.5-1 mm coronal to the radiographic apex^[4].

The accuracy of apex locators has been known to be influenced by various parameters like preflaring, the stage of instrumentation (based on conductivity of canals), apical constriction diameter, and the type of irrigants used. Curvature of the root canals is commonly encountered in clinical situations which could be another morphological influencing factor related to working length determination^[6, 7].

Hence; the present study was conducted for assessing the impact of root canal curvature on the accuracy of an electronic apex locator.

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Materials & Methods

The present study was conducted for assessing the impact of root canal curvature on the accuracy of an electronic apex locator. A total of 30 freshly extracted mandibular first molars were included in the present study. Only those tooth specimens were enrolled which didn't had any deformity, structural anomaly and in which complete root with varying degree of curvature was present. After cleaning with normal saline, all the specimens were stored in thymol solution. With the help of sodium hypochlorite, all the surface gross debris was removed from the root surfaces. At approximately at cemento-enamel junction, all the specimens were sectioned with the help of a diamond disk. Afterward, a number 10 K file was inserted into the root canals and the digital images were obtained in a bucco-lingual direction. The degree of root canal curvature was determined by Schneider's method. This was followed by grouping of all the samples broadly into three study groups as follows:

Group A: Specimens with mild canal curvature (Less than 20),

Group B: Specimens with moderate canal curvature (In between 20 and 36), and

Group C: Specimens with severe canal curvature (More than 36)

Pre-flaring of the canals was done using protapeing rotary instrument system.

Actual root canal length was determined through a number 10 file. This was named as actual working length (AL). Plastic cylindrical framework was made and freshly mixed alginate was poured in it for embedding the roots. The cylinder was placed in a plastic box filled with saline soaked sponge. Irrigation of the canals was done followed by removal of excess fluid. The lip clip was firmly secured to the box, with part of it dipped in saline. The file clip was attached to the file and the file inserted until the "Apex" reading was reached. This was marked as Electronic Working Length (EL). All the results were then recorded in Microsoft excel sheet and were analysed by SPSS software. Chi- square test was used for evaluation of level of significance.

Results

In the present study, a total of 30 freshly extracted mandibular first molars were included and were divided into three study groups- Group A: Specimens with mild canal curvature, Group B: Specimens with moderate canal curvature, and Group C: Specimens with severe canal curvature. Mean difference between AL and EL was 0.139 for group A, 0.273 for group B and 0.265 for group C. While comparing statistically, significant results were obtained while comparing in between group A and group B and between Group B and group C respectively. However; while comparing between group A and group C, non-significant results were obtained.

Table 1: Difference in AL and EL

Difference between AL and EL	Number of specimens		
	Group A	Group B	Group C
More than 1	0	0	0
0.5 to 1	1	0	0
0.01 to 0.5	2	1	1
0	0	0	0
-0.5 to -0.01	7	7	7
-1 to 0.5	0	2	2
-1	0	0	0

Table 2: Mean Value of difference between AL and EL

Group	Mean	SD
Group A	0.139	0.19
Group B	0.273	0.23
Group C	0.265	0.25

Table 3: Statistical distance

Group	T-value	P-value
Group A versus Group B	13.45	0.00*
Group B versus Group C	19.82	0.96
Group A versus Group C	-1.39	0.01*

*: Significant

Discussion

Root canal treatment is a standard procedure applied in veterinary dentistry. The indication for its implementation includes pulp disease and dental injuries. Working length measurement is significantly important for successful outcome of root canal treatment. According to contemporary views, the place up to which the root canal preparation and obturation should be performed is the narrow apical part of the root canal called the apical constriction (AC) which is located 0.5-1.0 mm coronal to the apical foramen [6-9]. Hence; the present study was conducted for assessing the impact of root canal curvature on the accuracy of an electronic apex locator.

In the present study, a total of 30 freshly extracted mandibular first molars were included and were divided into three study groups- Group A: Specimens with mild canal curvature, Group B: Specimens with moderate canal curvature, and Group C: Specimens with severe canal curvature. Mean difference between AL and EL was 0.139 for group A, 0.273 for group B and 0.265 for group C. Saatchi M *et al.* evaluated the correlation between accuracy of Root ZX electronic foramen locator and root canal curvature. One hundred and ten extracted mandibular molars were selected. Access cavity was prepared and coronal enlargement of mesiobuccal canal was performed. A #10 Flexo file was inserted into the mesiobuccal canal, and radiography was taken to measure the degree of curvature by Schneider's method. The actual working length (AWL) was defined by inserting the file until its tip could be observed at a place tangential to the major apical foramen and then 0.5 mm was subtracted from this measurement. For the electronic working length (EWL) measurement, the apical 3 or 4 mm of the root was embedded in alginate as the electrolyte material. The file was inserted into the root canal to the major foramen, until the APEX reading was shown on the electronic device and then pulled back until the visual display showed the 0.5 mm mark. The AWL was subtracted from the EWL to define the distance between the file tip and the point 0.5 mm coronal to the major apical foramen. Data were analyzed using the Pearson's correlation coefficient. The accuracy of Root ZX within ± 0.1 mm and ± 0.5 mm was 38.2% and 94.6%, respectively. There was no correlation between the distance from the EWL to the AWL and the degree of root canal curvature. Root canal curvature did not influence the accuracy of Root ZX foramen locator [10].

In the present study, while comparing statistically, significant results were obtained while comparing in between group A and group B and between Group B and group C respectively. However; while comparing between group A and group C, non-significant results were obtained. Piasecki L *et al.* evaluated the accuracy of 3 electronic apex locators (EALs) (CanalPro [Coltene-Endo, Cuyahoga Falls, OH], Apex ID

[SybronEndo, Glendora, CA], and Root ZX Mini [J Morita, Tokyo, Japan]) in curved mesial canals of extracted mandibular molars using micro-computed tomographic (micro-CT) scanning. The root canal length and the actual working length of 58 canals were measured using the visual method and 3-dimensional micro-CT reconstructions. The measurements of the EALs at marks "APEX/0.0" and "0.5 mark" were recorded as the electronic root canal length and the electronic working length, respectively. The absolute mean values and the percentages of distribution of the electronic measurements were compared with the actual lengths of the canals. The presence of isthmuses, accessory canals, foramen position, and the distance between the apical constriction and the apical foramen were recorded from the micro-CT scans, and their correlation to the accuracy of the EALs was determined. All electronic measurements showed high agreement with their respective gold standard, except the electronic root canal length of the Apex ID ($P < 0.05$). No difference in the percentage of precise measurements (within the ± 0.5 mm) was found among the devices (χ^2 and z tests, $P > 0.05$). Of the anatomic parameters evaluated, the presence of a lateral foramen negatively affected the 0.0 mark of the Apex ID (Wilcoxon test, $P < 0.05$). The Root ZX Mini and CanalPro were precise for both root canal length and working length determination in mesial curved canals of mandibular molars, whereas the Apex ID was accurate for the working length when using the 0.5 mark^[11].

Conclusion

From the above results, the authors concluded that electronic working length is slightly significantly affected with curvature of the root canal. However; when used with higher precision, electronic apex locators can be used regularly in dental practice with higher accuracy.

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