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ORIGINAL ARTICLE

Clinical reproducibility of Tri Auto ZX2 dedicated motor and electronic foraminal locator in determining rootcanal working length

ABSTRACT

Aim: *To evaluate the clinical reproducibility in determining the working length of Tri Auto ZX2 electronic foraminal locator (EFL) with instruments activated in OGP function by comparing the results obtained by this new device with those obtained by Root ZX II EFL.*

Methodology: *One hundred twenty-five teeth (72 vital and 60 non-vital pulps) were measured by Root ZX II EFL and Tri Auto ZX2 with instruments activated in OGP function to determine their respective working length, which was defined as a zero reading on the EFL. The instrument length was fixed with a rubber stop and measured with a caliper to an accuracy of 0.1 mm. The values obtained by Root ZX II and Tri Auto ZX2 were statistically compared by student t test with 5% of significance. The agreement between the different devices were determined in percentage. The statistical correlation was also used to determine the agreement between the two EFLs.*

Results: *There were no significant differences between tested EFLs measurements at "0.0" in vital, non-vital and in the overall analysis (P>0.05). Considering the agreement between devices, the results revealed 98.66% and 100% of concordant values in vital and non-vital pulps, respectively. The R_2 coefficient obtained was close to 1 in cases of vital pulp, non-vital pulp and in overall analysis, denoting a strong agreement between the EFLs.*

Conclusions: *The clinical reproducibility of Tri Auto ZX2 was confirmed when compared to Root ZX II.*

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Introduction

Accurate root canal length determination is an essential step in root canal therapy. The working length (WL) determination has a direct influence on root canal preparation and filling, and is considered a significant predictor of successful outcome in root canal therapy (1, 2). Root canal length can be determined using periapical radiographs, considering the radiographic apex as a reference for establishing the tooth length. To this, it is recommended a shortening regarding the radiographic apex in order to approach the apical constriction position. Even so, in most cases, the apical foramen does not coincide with the radiographic apex, which may lead to incorrect WL compared to the real position of the apical foramen (1, 2).

The use of electronic devices to determine the WL has become common. Several studies have been conducted on various commercially available electronic foramen locators (EFLs) and reported their accuracy and efficiency, even in adverse situations, such as the presence of blood or in cases of wide foramens (3-5). Additionally, the radiographic method has limitations that include image distortion, superimposition of roots and anatomical structures, and higher exposure to ionizing radiation when compared to EFLs methods (5).

Endodontic motors with integrated apex locators have been developed to continuously measure the WL during canal preparation. Root ZX II (J. Morita, Tokyo, Japan), Tri Auto ZX (J. Morita) and VDW Gold (VDW, Munich, Germany) are examples of such type of motors. These devices can be configured to have the EFL used isolated, like the standard EFLs, or a mode which the EFL and motor are activated simultaneously, with the first influencing the motor during the mechanical preparation. These motors have the capability to stop or reverse the activation of the nickel-titanium instrument as the estimated end point of the root canal is reached. Recently, the Tri Auto ZX2 motor with integrated EFL (J. Morita) was launched featured by the "optimum glide path (OGP)" mode, which is a combination of watch-winding-like and balanced-force-like reciprocating motions. The OGP motion is intended for safe glide path preparation, whereas scant information is available regarding the how such a movement influences the EFL readings during glide path preparation. Although the EFL of such motors seems to work on the same way that EFL not integrated to motors, the motion can have a direct influence on the working length determination.

Therefore, the aim of this study was to evaluate the clinical reproducibility in determining the working length of Tri Auto ZX2 EFL with instruments activated in OGP function by comparing the results obtained by this new device with those obtained by Root ZX II EFL. The null hypothesis tested was that there are no differences in the WL measures obtained by Tri Auto ZX2 and Root ZX II EFL.

Materials and Methods

This study was approved by the Local Ethics Committee (protocol number #550.788) and included an informed written consent in compliance with ethical principles obtained from each patient before the treatment was initiated. One hundred twenty-five teeth with fully formed apices, without root resorption and apical radiolucency in initial periapical radiographs were included. Teeth with previous endodontic treatment, internal or external root resorption, and/or intracanal calcification were excluded. Patients with active systemic disease and physical or mental disability were also excluded. Pulp tests revealed 72 vital and 60 non-vital pulps.

All clinical procedures and measurements were performed by a single experienced operator. Local anesthesia was administrated in all cases. Access cavities were prepared with round diamond burs and refined with an Endo-Z bur. When present, all metallic restorations were completely removed prior to conducting the measure-

ments. Then, rubber dam isolation of the tooth was performed. Root canals were irrigated during all endodontic treatment using 2.5% sodium hypochlorite. Excess fluid from the pulp chamber was removed, but canal was not dried before electronic measurements. Cervical root canal preparation was performed using a 40/.10 Race instrument (FKG Dentaire, La Chauxde-Fonds, Switzerland) inserted up to 2/3 of root canal length measured from initial radiograph. Then, electronic WL was performed using the Root ZXII EFL and a #15 C-Pilot instrument (VDW) until the device reach the "0.0" level, according to the manufacturer´s instruction. Measurements were considered to be valid if the reading remained stable for at least 5 s. The silicon stop was adjusted, and the distance between the silicon stop and the instrument tip was measured with a 0.1 mm precision digital caliper (Mitutoyo, Suzano, SP, Brazil). This length was recorded as Root ZX II Length (RZL). After that, 15/.02 Scout Race instruments (FKG Dentaire) were used in OGP function driven by the Tri Auto ZX2 device with automatic apical-stop activated until the zero reading was indicated by "Apex" or "0.0" in device display. At this time, radiographs were performed using a digital sensor (Kodak RVG 6100; Carestream, Rochester, USA). Then, instruments were removed, and the length was measured as described previously and recorded as Tri Auto ZX2 Length (TAL).

Statistical analysis

The values obtained by RZL and TAL were statistically compared by student t test with 5% of significance. The agreement between the different electronic WL devices were determined in percentage. The statistical correlation was also used to determine the agreement between the two EFLs. Statistical analysis was performed using SPSS (SPSS Inc., Chicago, IL, USA).

Table 1

Mean and standard deviation of measurements of tooth length using Root ZX II and Tri Auto ZX2

	Vital	Non-vital	Overall
Root ZX II	22.10±2.10^{A}	22.16±2.17^{A}	22.13±2.13^{A}
Tri Auto ZX2	22.11±2.10^{A}	22.16±2.17^{A}	22.14±2.13^{A}

The same capital letters represent no statistically significant difference between EFLs (P>0.05).

Results

There were no significant differences between tested EFLs measurements at "0.0" in vital, non-vital and in the overall analysis (P>0.05) (Table 1). Considering the agreement between devices, the results revealed 98.66% and 100% of concordant values in vital and non-vital cases, respectively. Figure 1 presents the statistical correlation of the WL determination of the two EFLs in cases of vital pulp, non-vital pulp and overall. The R_2 coefficient obtained was close to 1 in all conditions, denoting a strong agreement between the EFLs.

Discussion

Several studies have been conducted to evaluate the accuracy of EFLs in determining the WL with satisfactory results, especially after the advent of impedance based devices (3-6). These studies validated EFLs clinical use as a simple and effective alternative to the dubious determination of WL using periapical radiograph. Even the hybrid devices, which combine a dedicated electric motor to an EFL, seems to be precise when inserted until the apex foramen (7-10). However, to the best of the author's knowledge no study evaluated the recent launched Tri Auto ZX2 hybrid device under the OGP function clinically. Therefore, the present study assessed the clinical agreement of Tri Auto ZX2 EFL by comparing the results obtained with this new device with those obtained by Root ZX II EFL.

Considering the periapical radiograph limitations to adequately determine the WL, the present study adopted the Root ZXII EFL as a reference of comparison. The choice for Root ZX II was based on an extensive amount of *in vitro* and *in vivo* studies that have shown a good efficacy and accuracy of this EFL (11-13). In fact,

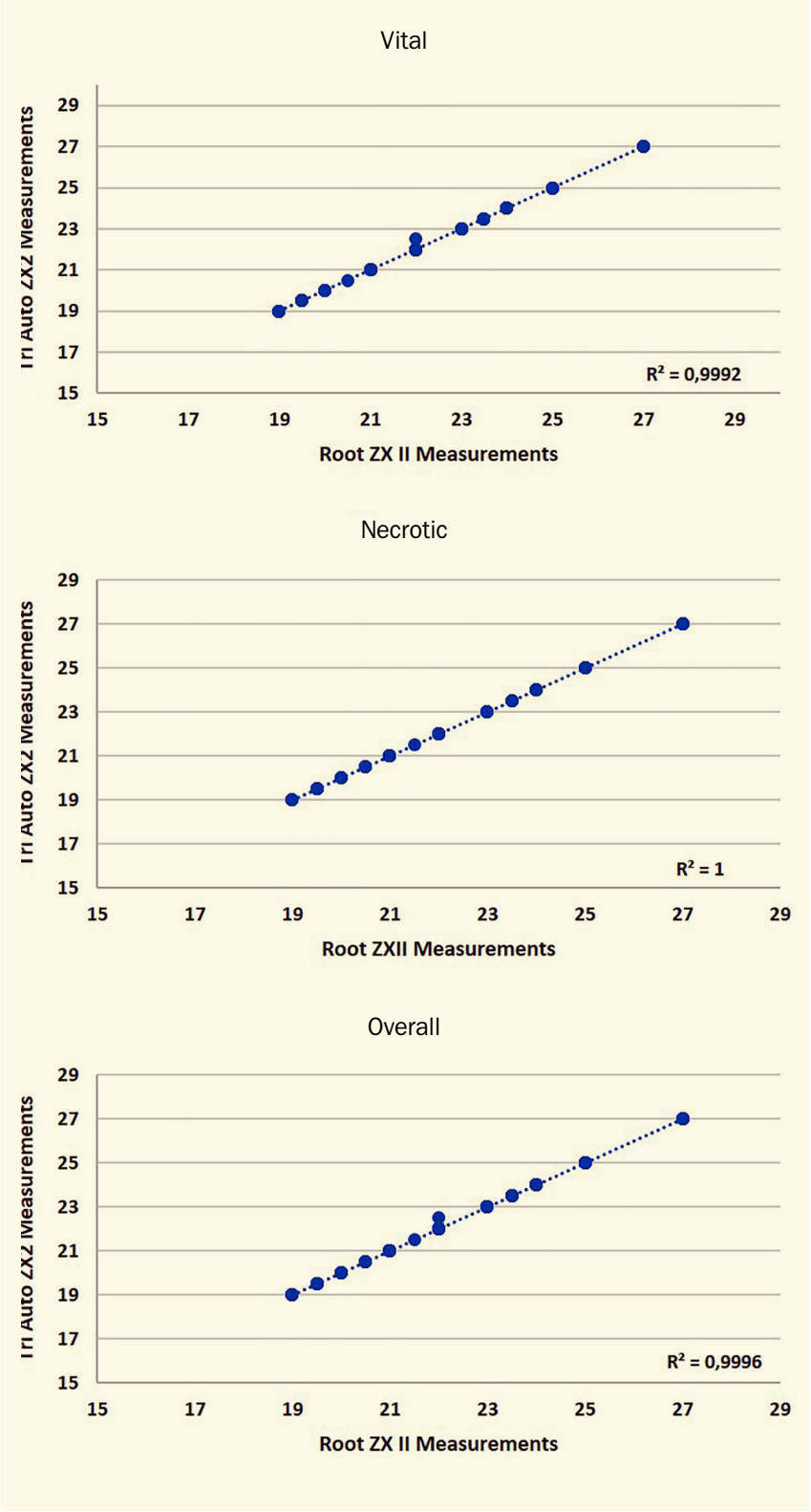

Figure 1
Statistical correlation of the working length determination between EFLs in vital, non-vital and overall cases.

several authors consider this EFL as the gold-standard. To check Tri Auto ZX2 accuracy and reproducibility, both devices were used until reach the apical foramen, at the "0.0" landmark, considered as the major foramen which is a position that can be consistently located (1, 5, 14).

The results of the present study point out that the coincidence of accuracy at the "0.0" landmarks of Tri Auto ZX2 and Root ZX II were 98.66% for vital pulp and 100% for non-vital pulps, with no differences between the two devices. This was also confirmed by the R_2 coefficient obtained which was close to 1 in all conditions, denoting a strong agreement between the EFLs. Therefore, the null hypothesis tested was upheld. Although this is the first study evaluating Tri Auto ZX2 device, previous studies demonstrated similar results when comparing EFL measurements with the measurements provided by electric motor combined to EFL with activated instrument (7-10). Although some previous studies reported that the accuracy of EALs was lower in the presence of non-vital canal content compared with the vital pulp tissue (5, 15), our results showed similar accuracy for both pulp conditions, which is in agreement with other reports (16, 17).

It is important to emphasize that comparisons of results should take in account the adoption of the same parameters of apical limits and the use of similar methods. In the present study, the standardization of the WL length measurements involved the irrigant concentration, coronal preparation, reference point and also the use of teeth serving as their own controls. This allows certain variables to be controlled in the clinical setting. Even so, some differences were present in the current experimental design, such as the use of different instruments (#15 stainless-steel C-Pilot, for the Root ZXII EFL and 15/0.02 NiTi Scout Race for Tri Auto ZX2). However, previous studies did not point out differences in foraminal length measurement when these different alloys were compared (18, 19). It is also important to emphasize that, although a direct comparison and the reproducibility between Root ZXII EFL and Tri Auto ZX2 were per-

formed, it is not possible to confirm the efficiency of both EFLs within the current study setup. However, it is well known that Root ZXII EFL is considered a gold-standard for foraminal length determination (4, 5, 11, 14), and in consequence it is suggested that Tri Auto ZX2 has a good efficiency. Even so, future *in vitro or in vivo* studies with different setups should be performed to confirm Tri Auto ZX2 clinical efficacy.

Conclusions

The clinical reproducibility of Tri Auto ZX2 EFL with instruments operated under OGP motion was confirmed when compared to Root ZX II.

Clinical Relevance

Tri Auto ZX2 EAL with instruments activated in OGP function seems to have a similar clinical performance of Root ZX II EFL.

Conflict of Interest

The authors declare that they have no conflict of interest.

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