ORIGINAL RESEARCH

Paper Point Technique vs Apex Locators' Measurement in Determining Working Length before Obturation in Curved Canals: An *In Vivo* Study

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Abstract

Aims: The aim of the present study is to evaluate the paper point technique (PPT) in curved canals, comparing this technique with the traditional electronic apex locator (EAL) evaluation.

Materials and methods: A total of 100 root canals with at least 30° of curvature according to Schneider's criteria in unsalvageable lower molars were evaluated in the present study. The working length (WL) was measured comparing traditional EAL evaluation and PPT, as described in the literature; therefore, the maximum length a paper point returned dry, without any visible sign of wetness, was recorded as the canal length according to PPT. All statistical analyses were performed using student's *t*-test. The significance level was set at $p < 0.05$.

Results: Between mean final EAL-WL (19.8 ± 0.4 mm) and mean paper points technique WL (19.2 ± 2.4 mm), there was a statistically significant difference, $p < 0.05$.

Conclusion: The present study found that PPT is not suitable for estimating the location of the apical foramen (AF) in curved canals. Despite the fact that the mean WL determination using the PPT was only 0.5 mm short of the WL determined with the apex locator, the results showed a high variability witnessed by the high standard deviation (SD), making the proposed technique unpredictable.

Clinical significance: The PPT alone cannot be considered a valid tool for WL determination. Despite this, it could be a valid support to confirm the EAL-WL, replacing the periapical X-radiation (X-ray) with instruments placed at WL and reducing this way the X-rays for the patient.

Keywords: Apex locator, Paper point, Root canal treatment, Working length determination.

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Introduction

Root canal treatment (RCT) is still based on Schilder's principles, shaping, cleaning, and filling.[1] Despite the fact that the above-mentioned cardinal principles did not change up to now, many endodontic innovations have been introduced in the last decades in different parts of the RCT procedures. The diagnostic phase has been revolutionized by the introduction of cone beam computed tomography, shaping has been revolutionized by the introduction of nickel-titanium rotary instruments, and cleaning has been revolutionized as well by the introduction of different cleaning system.[2–5]

Despite all these changes, some procedures have kept the same importance; among them, the working length (WL) establishment is still a key point during RCT. Indeed, a correct WL determination is mandatory to avoid short-term flare-ups and long-term unsuccess, to avoid periapical foreign body reactions and lack in the sealing of root canal apices.[6] The WL is the measurement of the root canal length from a coronal reference point up to the apex, where the shaping and the filling should terminate. Intraoperatively, the WL is usually measured using an electronic apex locator (EAL), but the same measurement can be made using radiographic evaluation, periodontal, and tactile sensitivity.[7–9] The two least techniques have been abandoned due to lack of precision.[10,11] Another proposed technique was the paper point technique (PPT).[12,13] This technique uses the paper point, usually used to dry the canal, to determine the WL. It is based on the purpose that the canal, adequately shaped and cleaned, is a dry environment, while the "outside" environment is a wet one. The PPT is used to determine the final WL after instrumentation because it needs a shaped canal. Therefore, the first WL needs to be obtained with another technique. Despite the WL determination with EAL being the gold standard, most clinicians still do not completely rely on EAL, usually looking for confirmation

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with an intraoperatory periapical X-radiation (X-ray). Despite the methodology above being completely accepted by most scientific endodontic associations, the literature is searching for a method that could avoid the patient's unnecessary X-ray exposure. For these reasons, the PPT has been more deeply studied in the last few years. Although Siqueira claimed that PPT for WL establishment is not reliable, Rosenberg claimed that PPT is accurate and precise to within 0.25 mm tolerances.[10] Moreover, Marcos-Arenal et al., stated that for relatively straight root canals, PPT appears to be like current clinically acceptable techniques in estimating AF location.[14]

Since the EAL-WL measurement is the gold standard in WL determination for both straight and curved canals and since in straight canals, the PPT technique seems to be reliable, the aim of the present study is to compare the effectiveness of the PPT compared to that with the apex locator for measuring the WL of curved endodontic canals.

Materials and Methods

The Sapienza University of Rome Ethical Committee Board approved this study (Ethical Committee 528/17). A total of 33 patients, from 20 to 63 years old, attending the Sapienza University of Rome School of Dentistry and its referral Policlinico Umberto I Hospital Dentistry Unit from January to June 2019 (each of whom had signed a detailed informed consent form) contributed with 40 lower molars planned for extraction for advanced periodontal lesions and mobility grade II, for a total of 100 canals. Inclusion criteria were—radiographic curvature angle at least of 30° according to Schneider's criteria, absence of root fracture and acute abscess, and coronal structure sufficient to allow the isolation with a rubber dam.

After anesthetizing the teeth, the rubber dam was placed to ensure isolation of the operative field. The pulp chamber was opened with a round bur on a high-speed handpiece under copious irrigation, and then a 10-k file with a rubber stop was used to determine the preoperative WL attached to an EAL, Root-ZX (J. Morita Mfg. Corp., Kyoto, Japan). The length from the file tip to the stopper was measured with an endodontic hand ruler (Dentsply Maillefer, Tulsa, Oklahoma, United States of America) with a precision of 0.5 mm under magnification 4×. The canals were shaped using a single file technique with F-one 25.06 (Fanta Dental Materials, Shanghai, China) attached in real-time with the above-mentioned EAL to avoid over-apex instrumentation. The chamber was filled with 5% sodium hypochlorite (NaOCl) always during the instrumentation phase. The canal space was recapitulated with small K-files and irrigated with NaOCl and 17% ethylenediaminetetraacetic acid (Pulpdent Corp, Watertown, MA) to ensure canal patency. After instrumentation a final WL, EAL-WL, was measured with the F-one 25.06, the stopper, and the Root-ZX, by the same operator, using the same coronal reference point and the same hand ruler under magnification 4×.

After EAL-WL determination, the canal was completely dried using the same taper and tip dimension (25.06) absorbent paper points (Roeko Coltene, Altstätten, Svizzera). At this point, another final WL, PPT-WL, was determined using PPT.[12–14] A new paper point of smaller taper and tip size than the canal, 20.04, was placed into the canal 2.0 mm shorter than the EAL-WL, kept 1 second at the chosen length, removed, and the tip checked for any visible sign of wetness. If the paper point was dry, the procedure was repeated with 0.5 mm length increments. The maximum length a paper point returned dry, without any visible sign of wetness, was recorded as the canal length according to PPT-WL. Dryness/wetness was verified visually under the magnification by the same operator with the same hand ruler mentioned above.

All statistical analyses were performed using student's *t*-test (IBM Corp. Released 2013. IBM Statistical Package for the Social Sciences Statistics for Windows, version 22.0. Armonk, New York: IBM Corp.), and the significance level was set at $p < 0.05$.

Results

As reported in Table 1, the mean initial WL measured using EAL was 20.5 ± 0.3 mm. The final mean EAL-WL was 19.8 ± 0.4 mm, while the mean PPT-WL was 19.2 ± 2.4 mm. Between initial and final mean EAL-WL, there was a statistically significant difference, $p < 0.05$. Same way, between the final mean EAL-WL and mean PPT-WL, there was a statistically relevant difference, $p < 0.05$. The shaping procedures shorten the initial length of the canal in a statistically relevant way.

Discussion

The present study investigated the accuracy of PPT to determine estimating the location of the apical foramen (AF). Evaluating PPT in this manner was interesting because the technique, to our knowledge, was already formally evaluated only in straight canals with promising performances. Most of the studies about the outcome of endodontic treatment assess the root-filling length only in relation to the radiographic apex. It is well known that X-ray working length does not necessarily correspond to the WL measured at the AF. Indeed, the radiographic apex is usually 0.5–2.0 mm shorter than AF-WL. In the current study, we aim to evaluate the PPT using AF as the landmark since the presence of the apical constriction, the location of the cementoenamel junction, nor the root apex-to-AF distance is reliable across canals, and the root apex has little relevance to the pathophysiology of periapical disease.[14]

Marcos-Arenal et al. stated that PPT was found to be suitable for estimating the location of AF in relatively straight canals because its performance was like current clinically acceptable standards of estimating AF location. Despite that, the above-mentioned study only tested straight canals. Moreover, the technique used in that study considered, for PPT-WL establishment, an advancement of 0.25 mm each time. Despite being more precise, this kind of measurement's precision is difficult to obtain during daily practice since the commonly used endodontic hand ruler has a precision of 0.5 mm. This difference in PPT-WL establishment and the use of severely curved canals could explain the different results of the two studies. Indeed, the results of the present manuscript showed not only the lower degree of precision of the PPT but also the high variability of this technique. While looking only at the mean value, it is only slightly less precise than EAL-WL, the high value of standard deviation (SD) means that the use of paper points to establish the WL is too often not reliable enough. To be more precise, the high SD value means that each measurement made with the PPT technique could not be realistic, with a range of mistakes of ±2.4 mm, which is undoubtfully clinically relevant. This could be due to small vital pulp residuals, a lateral canal in the apical third of the canal, or a small blood clot caused by instrumentation slightly beyond the apex, which is possible especially in curved canals since the WL

Table 1: Comparison of initial and final WL with the two techniques

	Initial WL (mm)	*Final WL (mm)*
EAL	20.5 ± 0.3	19.8 ± 0.4
PPT	\	19.2 ± 2.4

becomes shorter during shaping.[15,16] Moreover, another important limitation of this technique is given by the absorbency properties of the different paper points. Indeed, the study of Pumarola-Suñé et al. showed high variability in the absorbency properties of this dental accessory.[17] This variability could change the results of the study because a more efficient paper point could result in shorter WL determination with PPT, while a less absorbent one could give longer WL determination.

Even though PPT cannot be used as the only method for WL determination, it can be a useful auxiliary technique to confirm the WL already established using EAL. Indeed, way too often is still performed an X-ray to confirm the WL obtained with the EAL. This procedure is, on the one hand, useful to have a double check of WL, but on the contrary, it has a twofold problem, it requires the patient to perform an unnecessary X-ray and has traditional radiographic problems in WL determination, such as the difference between radiographic apex and anatomic apex. Therefore, the biological benefit of this technique compared to X-ray WL determination is relevant, despite the fact that it needs to be studied deeply to overcome its limits.

Conclusion

In conclusion, the present study found that PPT is not suitable for estimating the location of AF in curved canals. Despite the difference between the mean WL with the PPT and the mean WL with EAL being minimum, and this difference seems to be clinically acceptable for the estimation of AF location, the results showed a high variability witnessed by the high SD. Anyway, the PPT technique could be a valid support to confirm the EAL-WL, replacing the periapical X-ray with instruments placed at WL and reducing this way the X-rays for the patient. Since this is a clinical study with a consistent sample, it could be reliable to limit PPT for WL determination; anyway, since different paper points may have different absorbency, further studies are needed to evaluate the absorbency and the reliability of different paper points in WL determination.

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