Original Article

In vivo evaluation of the accuracy of working length determination using an electronic apex locater IPEX (NSK) on vital uninfected teeth and teeth with radiographic evidence of periapical lesions

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Abstract

Aim: To evaluate the accuracy of working length determination of an electronic apex locator, IPEX, on vital uninfected teeth and teeth with radiographic evidence of periapical lesions. **Materials and Methods:** Twenty vital and uninfected teeth and 16 teeth with a single canal and matured apices and having radiographic evidence of periapical lesions of 5–10 mm were taken for this study. Access cavities were prepared and pulp was considered to be vital if bleeding was present upon entering the chambers. No. 15 k-type file was used to determine the working length. X-rays were taken to determine the working length using Ingle's method, followed by determination using the electronic apex locator, IPEX. Teeth were then observed under 45 × magnification using stereomicroscope. No 15 k-type file was maneuvered till the emergence of the tip was seen and the real length of the tooth was thus measured in the instrument up to 0.5 mm accuracy using stereomicroscope. **Results:** The data were duly collected and entered, and the statistical analysis was done using Student's *t* test. In uninfected teeth, IPEX was found to be more reliable than Ingle's radiographic technique, but this was not statistically significant. In case of teeth with radiographic evidence of periapical lesions, the radiographic method appeared to be relatively more dependable; however, this difference was not statistically significant. **Conclusion:** For rendering effective root canal procedure, both radiographs and electronic apex locators have important roles to play.

Key words: *Electronic apex locator, Ingle's method, IPEX, periapical lesions, radiographs, working length*

INTRODUCTION

Success of endodontics depends on the diagnosis, treatment planning, access cavity preparation followed by cleaning and shaping, and obturation. One of the main concerns during root canal treatment procedure is how to determine or how far the working instruments should be advanced within the root canal and to what point the preparation and obturation should terminate.[1] Accurate determination of apical position has always been a challenge in clinical endodontics.[2]

There is a general consensus that the cementodentinal junction, the point where the pulp tissue changes into apical tissue, is the most ideal physiologic limit of the working length. It is also referred to as minor diameter or the apical constriction.[1,2]

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Since the time of introduction of endodontics as a speciality, research and debate have been focused toward inventing a method which would be consistent and dependable for locating the apical foramen all the time, irrespective of the clinical conditions.

It is imperative that root canal procedure be limited to within the root canal system. Chances of immediate and long-term complications and failures are higher if the canal is either underprepared or over-instrumented.

Several methods have been suggested ranging from tactile sensation method to electronic apex locators for locating the apical foramen correctly. Although radiograph is the most commonly used diagnostic and procedural aid in endodontics, it provides only a two-dimensional image.[1]

Determination of working length in root canal therapy using electronic means is an alternative approach that has generated considerable interest.[1] The idea of using electrical conductance for determining the location of apical position was conceived by Cluster long back in 1918 itself.[3]

Subsequently, in 1942, Suzuki devised a unit which could measure the electrical resistance between the periodontal ligament and the oral mucosa. He devised the unit based on the fact that the electrical resistance of oral mucosa and periodontal ligament is 6.5 kΩ.[4] Later on, in 1962, Sunada did work based on Suzuki's findings and reported that the electrical resistance concept is consistent.[5] Currently, the NSK Company has introduced an electronic apex locator device by name IPEX. As of now, there are many electronic apex locators in the market claiming superiority of each device. Hence study was undertaken to investigate and confirm the reliability of IPEX, in different clinical situations, to investigate the radiographic reliability for determining the working length on uninfected teeth and teeth with radiographic evidence of periapical lesions using Ingle's technique and differences, if any, in the reliability of IPEX versus radiographs.

MATERIALS AND METHODS

This study was undertaken in the Department of Conservative Dentistry and Endodontics, Raja Rajeswari Dental College and Hospital, Bangalore.

Twenty adult patients for whom extractions were indicated or advised for teeth with a single canal and matured apices, which were vital and uninfected, and 16 adult patients with a single canal and matured apices and having radiographic evidence of periapical lesions of 5–10 mm were considered for the study.

Inclusion criteria

Teeth with a single canal and advised for extraction of either vital uninfected teeth or teeth with radiographic evidence of lesions.

Exclusion criteria

Pregnant patients, teeth with calcified canals, teeth with external or internal resorption, retreatment cases, those with teeth of immature apex, teeth with fracture and mutilated teeth were excluded from the study.

After local anesthesia was administered by an oral surgeon, the experimental tooth was isolated with rubber dam. The cusps were flattened to create a proper reference point with a sterile tapered fissure bur. Endodontic access cavity was prepared into the pulp chamber with a sterile round bur. The pulp was considered to be vital if bleeding was present upon entering the chambers. The canals were irrigated with 3% sodium hypochlorite. Pulp from the pulp space was removed with a barbed broach. Gates Glidden drill no. 1 and 2 (Mani, Inc, Tochigi, Japan) were used. No. 10 k-type file was used to determine the patency of the canal. No. 15 k-type file was used to determine the working length. X-ray was taken to determine the working length using Ingle's method; then, using the electronic apex locator IPEX (NSK, Nakanishi, Japan), the working length was determined, and the data were duly entered (the materials and methods used in the study are shown in Figures 1 and 2, respectively).

The tooth was then extracted by the oral surgeon and stored in saline. Tooth was washed and then observed under 45× magnification using stereomicroscope. No. 15 k-type file was maneuvered till the emergence of the tip was seen, and the real and objective length of the tooth was thus measured in the instrument up to 0.5 mm accuracy using proper stereomicroscope. The results obtained were tabulated.

Statistical analysis was done by Student's *t* test and Pearson's correlation using SPSS Version 15.

RESULTS

The results obtained from Ingle's method, IPEX, and direct measurement under stereomicroscope of the extracted teeth were duly recorded in both vital

Figure 1: Materials used in the study

uninfected teeth and teeth with periapical lesions of 5–10 mm diameter [Tables 1 and 2].

In case of uninfected teeth, the *P* value in Ingle's method was 0.021 and in IPEX method was 0.577. In case of teeth with evidence of periapical lesions, the *P* value in Ingle's method was 0.188 and in IPEX was 0.164. The Ingle's method was marginally better than IPEX in case of teeth with lesions. However, it was not statistically significant. As per the results, there was no statistical difference between the two methods.

Table 3, Graph 1 and Table 4, Graph 2 show Pearson's correlation in vital uninfected teeth and teeth with radiographic evidence of lesions, respectively.

DISCUSSION

Grove stated, "the proper point to which root canals should be filled is the junction of the dentin and the cementum and the pulp should be severed at the point of its union with the periodontal membrane."[6]

Accurate determination of working length is one of the important initial steps in endodontic therapy. Ideal length determination at the beginning of treatment ensures precise and thorough cleaning and shaping, and obturation of the root canal. However, locating the appropriate apical position has always been a challenge in clinical endodontics.[2] One of the main concerns in root canal treatment is to determine how far the working instrument should be advanced within the root canal and at what point the preparation and obturation should be terminated.[1]

Failure to accurately determine the working length may result in either the length being too long leading to perforation of the apical constriction or the length being too short leading to incomplete preparation. Destruction of constriction may lead to overfilling

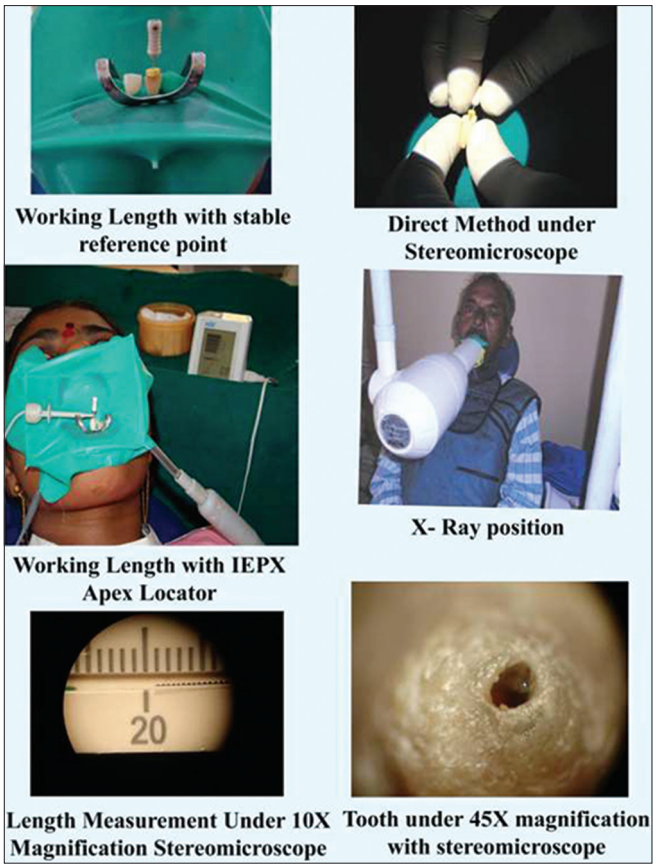


Figure 2: Method used for determining the working length

Table 1: Measurement of length in Ingle's method, EAL method, and direct method (standard method) in vital uninfected teeth

	Min-max	Mean±SD	Difference	*P*
Direct method	17.0-28.50	20.80±2.89	-	-
Ingle's method	17.00-21.00	20.67±2.79	0.13±0.22	0.021
EAL method	17.0-28.0	20.78±2.84	0.025±0.19	0.577

EAL=Electronic apex locator, EAL method is not statistically significant; this indicates that it is closer to standard method

Table 2: Measurement of length in Ingle's method, EAL method, and direct method (standard method) in teeth with radiographic evidence of lesions

Methods	Min-max	Mean±SD	Difference from standard	*P*
Magnifying: Standard	9.00-27.00	18.37±3.88	-	-
Ingle's	9.00-27.00	18.28±3.84	0.09±0.27	0.188
EAL	9.00-27.00	18.43±3.88	0.06±0.17	0.164

EAL=Electronic apex locator, Ingle's method is closer to standard method and is followed by EAL method, as both are not statistically significant with the standard method

Table 3: Pearson's correlation of Ingle's method and EAL method with magnifying method: Standard method in vital uninfected t eeth

	r	*P*
Magnifying method: Standard method vs. Ingle's method	0.999	<0.001
Magnifying method: Standard method vs. EAL method	0.998	<0.001

EAL=Electronic apex locator

Table 4: Pearson's correlation of Ingle's method and EAL method with magnifying method: Standard method in teeth with radiographic evidence of lesions

	r	*P*
Magnifying method: Standard method vs. Ingle's method	0.998	<0.001
Magnifying method: Standard method vs. EAL method	0.999	<0.001

EAL=Electronic apex locator

or overextension and an increased incidence of postoperative pain. In addition, it might lead to prolonged healing period and lower success rate owing to either incomplete regeneration of cementum, periodontal ligament, and alveolar bone or even the destruction of the alveolar bone.[7]

Shortened working length may result in incomplete preparation and inadequate apical seal, resulting in the persistence of viable bacteria and their by-products leading to failure. Therefore, for the success of treatment, determining the working length correctly is of paramount importance.

Over a period of time, many methods have been suggested and used for determining the working length. Each method has got its own advantages, disadvantages, and limitations. The usual methods in the order of simple to advanced and are as follows:

- Based on patient's response
- Tactile sensation
- Paper points
- Radiography – Grossman's method, Ingle's method,[8] Best method,[9] Weine's modifications,[10] Sunada method,[5] Bregmen method,[11] Bramante method,[12] xeroradiography, radiovisiography
- Apex locators.

Determining the length based on patient's pain response was in vogue in the early days of the growth of endodontics. As it is a subjective procedure, chances for false-positive and false-negative determinations are very high. Moreover, their uses in vital teeth are ruled out as the tooth and periapex are under anesthetic effect

Currently, the radiographic method is the most popular aid used in determining the working length. Many methods were proposed and out of these methods, a method suggested by Ingle is the simplest and most popular and is commonly used.

The radiographs have some inherent disadvantages, like the possibilities of radiation exposure, time consumption, lack of clarity or definition, film placement, and film processing. Radiographs are technique-sensitive in both their exposure and interpretation. Dense bone and anatomical structures can make the visualization of root canal files impossible by obscuring the apex.

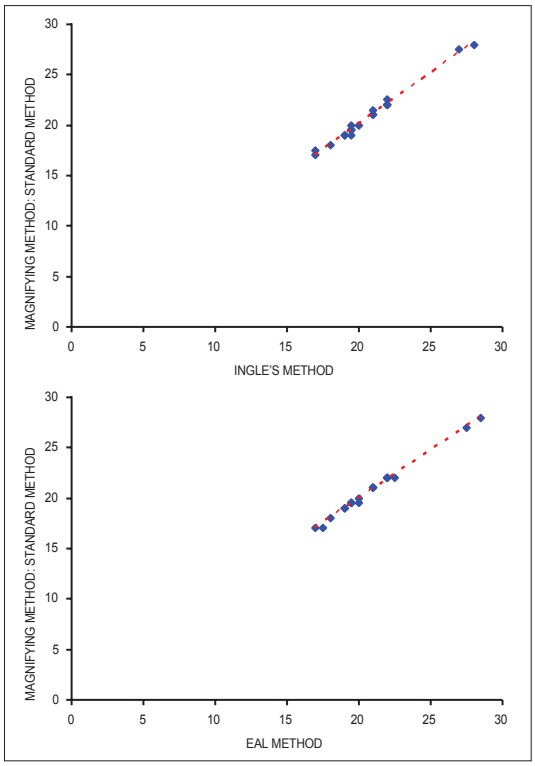
Several brands of electronic apex locators are available. Some companies declare the method of technology, whereas other companies maintain the patent rights and secrecy.

IPEX is one of the latest electronic apex locators available in the market which is manufactured by NSK. The technology details are kept as patent. This device was used for this study as it is not evaluated adequately in endodontic literature.

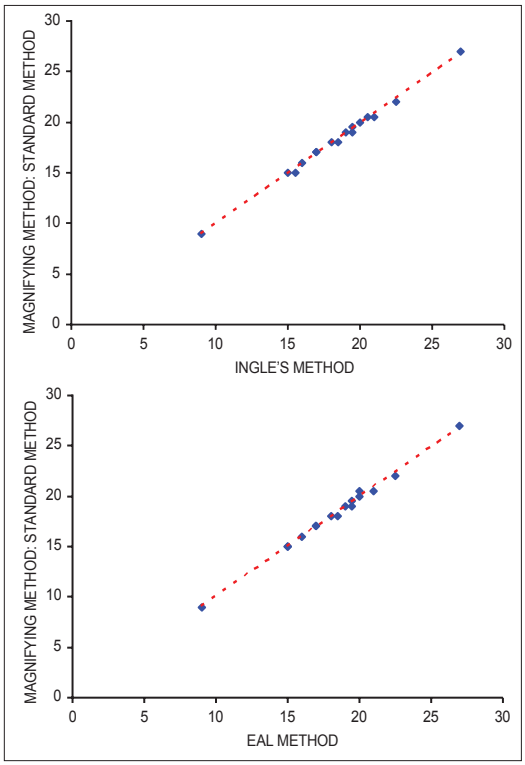
Not many studies have been done using the electronic apex locators, particularly IPEX, to evaluate their ability in determining the length of the teeth with periapical lesions. As the long-term failure rate is high in teeth with lesions, special care is generally required while the root canal treatment is done. It may safely be assumed that the correct determination of the working length is of significance. Therefore, in this study, such teeth were taken into consideration. As per the results obtained, there was no statistical difference between the two methodologies.

It is of interest to note that the Ingle's method is marginally better than the IPEX in case of teeth with periapical lesions. However, it is not statistically significant.

This study compared radiographs and electronic apex locators as a means of locating the foramen. Needless to say, radiographs, being two dimensional, have got the inherent limitations of helping in determining the location of the foramen. Added to this is the problem of inherent unpredictable nature of the location of the foramen, compounded by the aging factor and the resorptive factor. There is a great sense of belief and euphoria with the advancement in the technology of electronic apex



Graph 1: Pearson's correlation of Ingle's method, EAL method with magnifying method: standard method vital uninfected teeth



Graph 2: Pearson's correlation of Ingle's method, EAL method with magnifying method: standard method in teeth with radiographic evidence of lesions

locators. Electronic apex locators have had a long path of growth. It can be safely be said that instead of trying to argue which method is better, it is safe to mention that a prudent clinician may make use of both the devices and offer the best of services for the patient. It can also be stated that what radiographs can reveal, electronic apex locators cannot. Similarly, the advantages or the abilities of electronic apex locators surpass those of radiographs.

CONCLUSION

It may be concluded that that for effective root canal treatment, both the devices are of equal importance. However, basic knowledge of tooth morphology and periapical pathology would continue to be the foundation for success in endodontics and would go hand in hand with these devices.

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