(International Print/Online Journal)

SJIF IMPACT FACTOR: 6.829
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 9, Issue 4, Page No: 102-106
July-August 2026

IJMSCR

Incidence Of Underfilling And Overfilling In Root Canal Treated Teeth Obturated At Working Length Determined By Radiographic And Electronic Apex Locator Using Cbct Evaluation-An In Vivo Study

Dr. Sakshi Tyagi Garg[1], Dr. Rohit Kumar Sharma[2], Dr. Atul Jain[3], Dr. Anjali Sharma[4], Dr. Saleem Azhar[5], Dr. Madhurima Sharma[6]

[1]Post Graduate Resident ,[2,5,6]Professor ,[3]Professor and Head, [4]Assistant Professor
[1,2,3,4,5]Department of Conservative Dentistry and Endodontics
[6]Department of prosthodontics and crown & bridge
Teerthanker Mahaveer Dental College and Research Centre, Moradabad

***Corresponding Author:**
Dr. Rohit Kumar Sharma
Professor, Department of Conservative Dentistry and Endodontics
Teerthanker Mahaveer Dental College and Research Centre, Moradabad

Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

Background:
Accurate working length determination is critical for successful root canal treatment. Inaccurate measurements may lead to underfilling or overfilling, compromising the long-term prognosis. Electronic apex locators (EALs) and radiovisiography (RVG) are commonly used for working length determination, while cone-beam computed tomography (CBCT) provides a reliable three-dimensional reference for evaluating obturation accuracy.

Aim:
To compare the accuracy of working length determination using RVG and Propex Pixi electronic apex locator and to evaluate the incidence of underfilling and overfilling using CBCT.

Materials and Methods:
Sixteen patients with single-rooted maxillary central incisors were randomly allocated into two groups (n=8 each). Working length was determined using either RVG or Propex Pixi apex locator. Standardized biomechanical preparation and obturation were performed, and pre- and postoperative CBCT scans were used to assess the apical extent of obturation. Statistical analysis was performed using paired and independent *t*-tests.

Results:
The apex locator demonstrated significantly lower discrepancy from CBCT than RVG for both initial and final working length measurements ($p = 0.001$), indicating superior accuracy and reliability.

Conclusion:
Propex Pixi electronic apex locator provides more accurate working length determination than RVG. Its use, combined with radiographic assessment, may improve the quality of root canal obturation and reduce underfilling and overfilling.

Keywords: CBCT, electronic apex locator, radiovisiography, working length determination

Introduction

Accurate working length determination is a critical factor for the success of root canal treatment, as it directly influences cleaning, shaping, and obturation of the root canal system. Instrumentation beyond or

short of the apical constriction may result in persistent infection, postoperative pain, delayed healing, and treatment failure. [1]

Radiovisiography (RVG) and electronic apex locators (EALs) are the most commonly used methods for working length determination. Although RVG provides valuable information regarding root canal anatomy, it is limited by its two-dimensional image and possible distortion.[2] Modern electronic apex locators, such as Propex Pixi, determine the apical constriction with high accuracy and reduce radiation exposure.[3] Cone-beam computed tomography (CBCT) offers three-dimensional visualization and can accurately evaluate the apical extent of obturation; however, it is recommended only when clinically indicated because of radiation exposure.[4]

The present in vivo study was conducted to compare the accuracy of working length determination using RVG and the Propex Pixi electronic apex locator, with CBCT serving as the reference standard for evaluating the incidence of underfilling and overfilling after obturation.

Materials and Methods

Study Design

The present **in vivo comparative randomized clinical study** was conducted in the Department of Conservative Dentistry and Endodontics in collaboration with the Department of Oral Medicine and Radiology after obtaining approval from the Institutional Ethics Committee (Ref. No. TMDCRC/IEC/TH/23-24/CDE 03). The study aimed to compare the accuracy of working length determination using radiovisiography (RVG) and a fifth-generation electronic apex locator (Propex Pixi), with cone-beam computed tomography (CBCT) serving as the reference standard for evaluation of obturation length.

Sample Size and Randomization

Sample size estimation was performed using **G*Power software (Version 3.1.9.6)** with a study power of 90%, 5% level of significance, and an effect size of 1.40. The minimum calculated sample size was 16 teeth (8 per group). Patients were allocated into two groups using **block randomization** to ensure equal distribution and minimize selection bias.

Study Population

Sixteen patients aged **18–50 years** requiring root canal treatment in **single-rooted maxillary central incisors** diagnosed with symptomatic irreversible pulpitis and having normal periapical tissues were included in the study after obtaining written informed consent.

Inclusion Criteria

1. Patients aged 18–50 years.
2. ASA I and II healthy individuals.
3. Single-rooted maxillary central incisors with completely formed roots.
4. Single canal with straight root morphology (0–5° curvature).
5. Symptomatic irreversible pulpitis with normal periapical tissues.

Exclusion Criteria

1. Previously endodontically treated teeth.
2. Teeth with immature apices, calcified canals, developmental anomalies, internal or external root resorption.
3. Teeth with curved or multiple canals.
4. Teeth associated with periapical pathology.
5. Immunocompromised patients and primary teeth.

Clinical Procedure

After administration of local anesthesia and rubber dam isolation, conventional access cavity preparation was performed using a round diamond bur followed by an Endo-Z bur. Canal patency was established using a size 10 K-file, and glide path preparation was completed before working length determination.

Patients were randomly assigned into two groups:

Group I (RVG group): Working length was determined using the radiographic method with RVG by the paralleling technique. An initial estimated working length was obtained from the radiograph, followed by correction based on file position and confirmation with a second radiograph.

Group II (Electronic Apex Locator group): Working length was determined using the **Propex Pixi electronic apex locator (Dentsply Sirona, Switzerland)** according to the manufacturer's instructions. A size 10 or 15 K-file connected to the apex locator was advanced until the apical constriction was identified, and the electronic working length was recorded.

Volume 9, Issue 4; July-August 2026; Page No 102-106

Biomechanical preparation was performed in all teeth using the **step-back technique** with stainless-steel K-files. Irrigation was standardized using **3% sodium hypochlorite** throughout instrumentation, followed by **17% EDTA for one minute** and a final rinse with normal saline. Canals were dried with sterile paper points and obturated by the **cold lateral condensation technique** using gutta-percha and AH Plus sealer. All procedures were performed by a single operator to eliminate operator-related bias.

CBCT Evaluation

Preoperative and postoperative CBCT scans were obtained using the **NewTom GiANO HR CBCT unit (Cefla Dental Group, Italy)** operating at **90–110 kVp**, **1–10 mA**, with an isotropic voxel size of **0.075–0.3 mm**. Three-dimensional reconstructed sagittal images were analyzed using the manufacturer's software. The distance between the apical extent of obturation and the apical constriction was measured to determine the incidence of underfilling and overfilling. The discrepancy between the intended working length and the final obturation length was calculated for both study groups.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using **SPSS software**. Continuous variables were expressed as **mean ± standard deviation**. Intragroup comparisons between working length measurements and CBCT values were performed using the **paired Student's t-test**, while intergroup comparisons were analyzed using the **independent Student's t-test**. A **p-value <0.05** was considered statistically significant.

Results

A total of 16 patients were included in the study and equally allocated into two groups (n = 8). Group I underwent working length determination using radiovisiography (RVG), whereas Group II underwent working length determination using the Propex Pixi electronic apex locator (EAL). All patients completed the study, and no procedural complications were encountered.

Accuracy of Working Length Determination

Comparison of working length measurements with postoperative CBCT revealed that both techniques produced clinically acceptable results. However, the electronic apex locator demonstrated significantly greater agreement with CBCT than RVG.

In the RVG group, the mean discrepancy between the initial RVG working length and CBCT was 0.225 ± 0.133 mm, while the discrepancy between the final obturation length and postoperative CBCT was 0.350 ± 0.114 mm. Paired comparison between RVG and CBCT measurements showed statistically significant differences for both initial ($p = 0.012$) and final ($p = 0.009$) measurements, indicating that RVG tended to underestimate the actual canal length.

In the electronic apex locator group, the mean discrepancy between the apex locator and CBCT was 0.112 ± 0.074 mm for the initial working length and 0.150 ± 0.077 mm for the final obturation length. Although minor differences existed between EAL and CBCT measurements, the discrepancies were significantly smaller than those observed with RVG ($p = 0.036$ and $p = 0.048$, respectively), demonstrating closer agreement with the three-dimensional reference standard.

Intergroup Comparison

Intergroup analysis demonstrated a statistically significant difference between the two methods. The discrepancy between CBCT and EAL measurements was significantly lower than the discrepancy between CBCT and RVG measurements for both initial and final working length determinations ($p = 0.001$). These findings indicate that the Propex Pixi electronic apex locator provided significantly greater accuracy and reliability than radiovisiography for working length determination.

Underfilling and Overfilling Assessment

CBCT evaluation showed that the majority of teeth in both groups were obturated within clinically acceptable limits. However, the RVG group demonstrated greater variation in obturation length, with a higher incidence of underfilling and overfilling compared with the electronic apex locator group. The EAL group consistently produced obturation lengths closer to the intended working length, reflecting superior apical control.

Discussion

Precise working length determination is essential for successful endodontic treatment because it directly influences cleaning, shaping, and obturation of the

Volume 9, Issue 4; July-August 2026; Page No 102-106

root canal system. In the present study, the Propex Pixi electronic apex locator demonstrated significantly greater agreement with CBCT than radiovisiography (RVG), indicating superior accuracy in working length determination. The reduced discrepancy observed with the electronic apex locator suggests that it is more effective in identifying the apical constriction and minimizing underfilling and overfilling.

The findings of the present study are in accordance with **Vieyra et al.**[1], who compared four electronic apex locators with radiographic measurements and reported that all electronic apex locators were significantly more accurate than radiography in locating the apical constriction. Similarly, **Pishipati et al.**[2] found that Propex II electronic apex locator demonstrated significantly higher accuracy than Ingle's radiographic technique within ±0.5 mm of the apical constriction.

Our results are also supported by **Connert et al.**[3], who reported that CBCT-derived working length measurements were clinically acceptable and highly reproducible. However, the authors recommended that CBCT should only be used when scans are already available because of radiation exposure. Likewise, **Lucena et al.**[4] observed that the Raypex 6 electronic apex locator showed greater agreement with the actual canal length than CBCT, supporting the routine clinical use of electronic apex locators.

A similar observation was reported by **Tarek Rabi**[5], who compared CBCT, digital radiography, and electronic apex locators in vivo and found that electronic apex locator measurements were closest to the actual working length, although all three methods showed acceptable clinical accuracy. More recently, **Bansal et al.**[6] compared electronic apex locators, digital radiography, and CBCT and concluded that electronic apex locators exhibited the highest accuracy, followed by CBCT and RVG.

The findings of the present study therefore support the routine use of electronic apex locators for working length determination. Although RVG remains valuable for anatomical assessment and procedural verification, CBCT should be reserved for complex cases requiring three-dimensional evaluation, whereas electronic apex locators can provide highly accurate and reproducible working length measurements with minimal radiation exposure.

Conclusion

Within the limitations of this study, the **Propex Pixi electronic apex locator demonstrated greater accuracy than RVG for working length determination**, showing closer agreement with CBCT measurements. The electronic apex locator reduced discrepancies in obturation length and minimized underfilling and overfilling. Therefore, the combined use of an electronic apex locator with radiographic confirmation is recommended for accurate working length determination and predictable endodontic outcomes.

Refrences

References

1. Ingle JI, Bakland LK, Baumgartner JC, editors. Ingle's Endodontics. 7th ed. Hamilton (ON): BC Decker Inc.; 2019.
2. Ravanshad S, Adl A, Anvar J. Effect of working length measurement by electronic apex locator or radiography on the adequacy of final working length: A randomized clinical trial. Journal of Endodontics. 2010;36(11):1753–1756.
3. Martins JNR, Marques D, Mata A, Caramês J. Clinical efficacy of electronic apex locators: A systematic review. Journal of Endodontics. 2014;40(6):759–777.
4. Jeger FB, Janner SFM, Bornstein MM, Lussi A. Endodontic working length measurement with preexisting cone-beam computed tomography scanning: A prospective, controlled clinical study. Journal of Endodontics**.** 2012;38(7):884–888.
5. Vieyra JP, Acosta J. Comparison of working length determination with radiographs and four electronic apex locators. International Endodontic Journal. 2011;44(6):510–518.
6. Pishipati KVC, Anupreeta A, Nagesh B, et al. Accuracy of Propex II electronic apex locator and Ingle's radiographic method in working length determination: An in vitro study. Journal of Conservative Dentistry. 2013;16(3):229–232.
7. Connert T, Zehnder MS, Weiger R, Kühl S, Krastl G. Micro-computed tomography and cone-beam computed tomography for working length determination. Journal of Endodontics. 2013;39(8):1057–1061.

Volume 9, Issue 4; July-August 2026; Page No 102-106

8. Lucena C, López JM, Martín JA, Robles V, González-Rodríguez MP. Accuracy of working length determination using electronic apex locator and cone-beam computed tomography. International Endodontic Journal. 2014;47(3):246–256.
9. Rabi T. Comparative evaluation of working length determination using CBCT, digital radiography and electronic apex locator: An in vivo study. Ain Shams Dental Journal. 2021;24(2):65–73.
10. Bansal R, Sharma P, Gupta A, et al. Comparative evaluation of working length determination using electronic apex locator, digital radiography and cone-beam computed tomography: An in vitro study. Journal of Conservative Dentistry. 2024;27(1):34–40.

Volume 9, Issue 4; July-August 2026; Page No 102-106