

**University of Mosul
College of Dentistry**



**A comparative Evaluation of Working Length
Determination with Different Techniques in Straight
and Curved Canals: An In Vitro Study**

**A Thesis Submitted
By**

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**To
The Council of College of Dentistry
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As a Partial Fulfillment of the Requirements
For the Degree of Master of Science
In
Conservative Dentistry**

**Supervised by
Assistant Professor
Dr. Ali Moayid Rasheed**

ABSTRACT

Aims of the Study: This study aims to compare the accuracy of several methods for determining working length in straight and curved canals, using: two types of electronic apex locators, digital radiograph, cone beam computed tomography and micro-computed tomography.

Materials and Methods: A total of 60 extracted human permanent teeth were used: 20 mandibular premolars with straight root canals (curvature angle $< 5^\circ$) and 40 mandibular molars (mesial roots) with curved roots (curvature angle $> 5^\circ$). All the collected teeth that were extracted for either periodontal, prosthetic, or orthodontic reasons were included in this study. The canal curvature was detected according to Schneider's approach, and the teeth were categorized into three groups: Group I: straight if the angle is $\leq 5^\circ$, Group II: curved if the angle is $> 5^\circ$ and $\leq 20^\circ$, and Group III: severely curved if the angle is $> 20^\circ$. After sectioning the teeth at the cement-enamel junction (CEJ), the patency of the canal and the major foramen was assessed using size #10 k-file, and then the coronal flaring was performed using Gate Gliddens (#4, #3, and #2). Several methods were utilized: the electronic apex locators (Root ZX Mini and Raypex6), digital radiography, cone beam computed tomography, and μ -CT analysis to measure the working length of the root canal. μ -CT analysis statistically compared the WL measurements obtained by different methods in canals with various anatomies. Statistical analysis was performed utilizing One Way Analysis of Variance (ANOVA) and the significance level was established at $p < 0.05$.

Results: Regardless of curvatures all groups of working length measurements demonstrated excellent agreement with their corresponding μ -CT data. With the exception of the severely curved root canal ($P < 0.05$) especially for digital radiograph and raypex6 electronic apex locator, while for RootZX mini and CBCT the ($p > 0.05$).

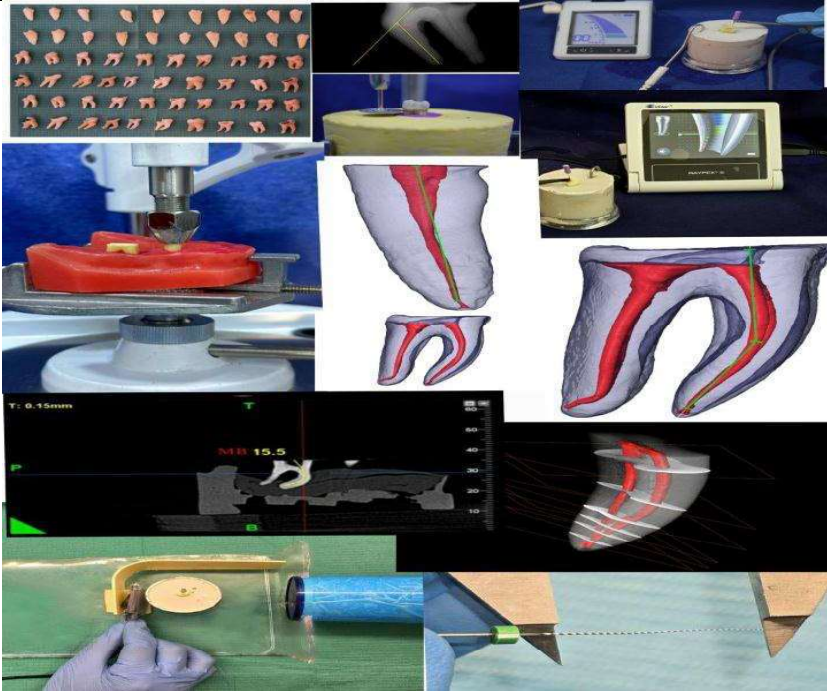
Conclusion: Working length determination in mandibular premolars and mesial curved canals of mandibular molars with curvature angles between 5 and 20 degrees was accurate with all methods but not with those whose curvature angles were greater than 20 degrees.

A comparative Evaluation of Working Length Determination with Different Techniques in Straight and Curved Canals: An In Vitro Study

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HIGHLIGHTS	GRAPHICAL ABSTRACT
-No significant difference was observed between straight group($\leq 5^\circ$) and curved group($> 5^\circ$ and $\leq 20^\circ$). -A difference was observed in for severely curved group($> 20^\circ$) -The accuracy of (RootZX mini EAL and CBCT) was reable among the straight, curved, and severely curved root canals -The accuracy of (digital radiograph and Raypex6® EAL) methods was considered unreable in severely curved root canals.	
Keywords: CBCT, Digital radiograph, Root ZX Mini, Raypex6, μ-CT, Working length.	ABSTRACT Aims of the Study: This study aims to compare the accuracy of several methods for determining working length in straight and curved canals, using: two types of electronic apex locators, digital radiograph, cone beam computed tomography and micro-computed tomography. Materials and Methods: A total of 60 extracted human permanent teeth were used: 20 mandibular premolars with straight root canals (curvature angle $< 5^\circ$) and 40 mandibular molars (mesial roots) with curved roots (curvature angle $> 5^\circ$). All the collected teeth that were extracted for either periodontal, prosthetic, or orthodontic reasons were included in this study. The canal curvature was detected according to Schneider's approach, and the teeth were categorized into three groups: Group I: straight if the angle is $\leq 5^\circ$, Group II: curved if the angle is $> 5^\circ$ and $\leq 20^\circ$, and Group III: severely curved if the angle is $> 20^\circ$. After sectioning the teeth at the cement-enamel junction (CEJ), the patency of the canal and the major foramen was assessed using size #10 k-file, and then the coronal flaring was performed using Gate Gliddens (#4, #3, and #2). Several methods were utilized: the electronic apex locators (Root ZX Mini and Raypex6), digital radiography, cone beam computed tomography, and μ-CT analysis to measure the working length of the root canal. μ-CT analysis statistically compared the WL measurements obtained by different methods in canals with various anatomies. Statistical analysis was performed utilizing One Way Analysis of Variance(ANOVA) and the significance level was established at $p < 0.05$. Results: Regardless of curvatures all groups of working length measurements demonstrated excellent agreement with their corresponding μ-CT data. With the exception of the severely curved root canal ($P < 0.05$) especially for digital radiograph and raypex6 electronic apex locator, while for RootZX mini and CBCT the ($p > 0.05$). Conclusion: Working length determination in mandibular premolars and mesial curved canals of mandibular molars with curvature angles between 5 and 20 degrees was accurate with all methods but not with those whose curvature angles were greater than 20 degrees. 2025 M.Sc. Thesis @Univ. of Mosul, College of Dent., Cons. Dent. Dept. (https://www.uomosul.edu.iq/).



جامعة الموصل
كلية طب الاسنان

تقييم مقارنة لتحديد طول العمل باستخدام تقنيات مختلفة في القنوات المستقيمة والمنحنية: دراسة مختبرية

رسالة تقدمت بها
أفنان اسماعيل محمد أسعد

الى
مجلس كلية طب الاسنان في جامعة الموصل
كجزء من متطلبات نيل شهادة الماجستير في علوم علاج الاسنان التحفظي
في
علاج الأسنان التحفظي

بإشراف
الأستاذ المساعد الدكتور
علي مؤيد رشيد

الخلاصة

الأهداف: تهدف هذه الدراسة إلى مقارنة دقة عدة طرق لقياس طول العمل في القنوات المستقيمة والمنحنية باستخدام: جهاز تحديد قمة الجذر الإلكتروني (Root ZX Mini and Raypex6)، والأشعة السينية الرقمية، والتصوير المقطعي المحوسب (CBCT) والتصوير المقطعي بالأشعة السينية (μ -CT).

المواد والطرق: أستخدمت في الدراسة ٦٠ سنّاً دائماً بشرية مستخرجة، (٢٠) ضرساً صغيراً فكياً سفلياً بقنوات جذرية مستقيمة (زاوية أقل من ٥°) و (٤٠) ضرساً كبيراً فكياً سفلياً (جذور وسطية) بقنوات جذرية منحنية (زاوية أكثر من ٥°). جميع الأسنان المجمعة التي تم استخراجها لأسباب periodontale أو prosthetic أو orthodontic تم تضمينها في هذه الدراسة. تم اكتشاف انحناء القناة وفقاً لنهج شنايدر، وتم تصنيف الأسنان إلى ثلاث مجموعات: المجموعة الأولى: مستقيمة إذا كان الزاوية $\geq ٥^\circ$ ، المجموعة الثانية: منحنية إذا كان الزاوية $< ٥^\circ$ و $\geq ٢٠^\circ$ ، والمجموعة الثالثة: منحنية بشدة إذا كان الزاوية $< ٢٠^\circ$. بعد قطع الأسنان عند منطقة التقاء المينا والعاج (CEJ)، تم تقييم نفاذية القناة والثقب الرئيسي باستخدام ملف كير #١٠، ثم تم إجراء التوسيع التاجي باستخدام مثاقب Gate Glidden (#٤، #٣، و#٢). تم استخدام عدة طرق؛ جهاز (Root ZX Mini and Raypex6)، والأشعة السينية الرقمية، والتصوير المقطعي المحوسب (CBCT)، وتحليل μ -CT لتحديد طول العمل لقناة الجذر. تمت مقارنة قياسات طول العمل (WL) التي تم الحصول عليها بطرق مختلفة في تشريح قنوات الجذور المختلفة إحصائياً باستخدام تحليل μ -CT. تم تحديد مستوى الدلالة عند $p \leq 0.05$. النتائج: بغض النظر عن الانحناءات، أظهرت جميع مجموعات قياسات طول العمل توافقاً ممتازاً مع بيانات μ -CT المقابلة لها. باستثناء قناة الجذر المنحنية بشدة ($P \leq 0.05$).

الخلاصة: كان تحديد طول العمل في الأضراس السفلية والقنوات المنحنية القريبة من الأضراس السفلية بدقة مع جميع الطرق في الزوايا المنحنية بين ٥ و ٢٠ درجة، ولكن ليس مع تلك التي كانت زوايا انحنائها أكبر من ٢٠ درجة.