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Comparative clinical assessment of working length endomotor apex locator versus radiographic method in endodontic therapy.

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Abstract:

Introduction: The technological and therapeutic advancements suggests that, choosing an appropriate endodontic approach is the key parameter to mitigate over radiation exposure and locating precise root canal length.

Objective: Current study aims to evaluate the comparative accuracy of working length apex locator versus radiographic apex locator in in endodontic therapy among patients belonging from Sindh, Pakistan.

Methodology: Current four-month duration based cross-sectional study focusing endodontic therapeutic techniques was conducted at Bibi Aseefa Dental College Larkana Sindh Pakistan. 124 patients requiring non-surgical root canal therapy were included in the study for working length apex locator and radiographic apex locator techniques. Film positioner were used to assess the morphology and initial working length of tooth by radiographic apex locator technique. Whereas glide path and working length was achieved with #12/02 M3 – Pro Gold File (United Dental) with 00 reading in Endo-Matic apex locator. Further data analysis was achieved with SPSS Version 20 and Microsoft Office 2010 multiple tools.

Results: Among 124 patients, 69 (55.6%) were males and 55 (44.4%) were females with mean age of 33.60 ± 12.87 years. We found comparative accuracy of 77 % of working length apex locator in terms of apical limit determination. Whereas, in case of radiographic apex locators 70 % accuracy was recorded.

Conclusion: Working length endomotor with built in apex locators provide satisfactory control of apical limit of endodontic treatment and better time saving option, however radiographic confirmations remain the confirmatory length measurement tool to identify the dimension of canal and path obtained by endodontic instrument.

Keywords: EndoMatic, Electronic Apex Locators, Hybrid Endomotors, Radiograph, Working Length.

Introduction:

Scientific technological advancement has revolutionized the general dentistry specially in restorative aspect of dentistry. Various materials and equipment have been developed to ease the dental procedures and make cost effective treatment feasible. Root canal therapy is one of the most common procedure in restorative dentistry and studies have showed a success rate of more than 90%¹, while on the other hand, failure rate of approximately 35.2%² has been reported to

be affected by experience³ and anatomical difficulties⁴. Working length in endodontic is defined as the distance from a coronal reference point to the point at which canal preparation and obturation should finish. It is one of the important steps in root canal therapy as studies' results showed; not maintain working length results in under filling or overfilling of obturating material, apical perforation and inadequate cleaning which is associated with increase in post-operative pain and decrease success of endodontic therapy⁵. Cemento-dentinal junction also known as minor apical diameter denotes the conversion between pulpal and periodontal tissue and it is the point which is indicated in histological studies to be the end point of obturating material in the root canal⁶. Historically working length is measured by tactile, peri-apical sensitivity, paper point bleeding points, and radiographic methods⁷. However, none of the above-mentioned methods have clearly identified the minor apical constriction to which to terminate the endodontic procedure⁸. The limitation of radiograph working length interpretation include obscuring of apical structures with overlapping roots and other anatomical structures of jaws, warp, shortening and elongation of structures, inter and intra person inconsistency electronic apex locators are currently introduced to determine the apical constriction as close as possible while avoiding the radiation from radiograph to patient. Electronic apex locators measure the working length through calculating the impedance of different frequencies between file tip and periodontal tissue⁹. Working length measurement with apex locators are validated in many studies¹⁰⁻¹². But comparative assessment of working length apex locator versus radiographic apex locator in endodontic therapy is still debatable. Choosing case specific technique in clinical settings at local level is considered a major challenge for dental physicians. Current study formulated a complex hypothesis that, working length apex locators are more plausible choice in apical limit determination and time saving, whereas radiographic apex locators are more accurate in assessment of root canal dimensions declaring a significant relationship between both techniques.

Methodology:

This cross-sectional study was conducted at Bibi Aseefa Dental College Larkana Sindh from January 2021 to April 2021. Patients from age ranges 12 – 60 years requiring non-surgical root canal therapy were included in the

study. While the patients with apical resorption, open apex and metallic or ceramic restoration, retreatment cases, root fractured, and calcified canals were excluded for further assessment.

A pre-operative radiograph was obtained with film positioner to assess the morphology and initial working length of tooth under treatment. Following Local anesthetic administration, isolation of teeth was achieved with rubber dam. After access preparation, glide path was achieved, and the working length was obtained with #12/02 M3 – Pro Gold File (United Dental) with 00 reading in EndoMatic. The working length was measured and recorded in proforma. After achieving preliminary working length from initial radiograph, subtraction of 1 mm was achieved, and file was again inserted into canal with stopper at stable reference point on teeth and radiograph was taken by paralleling technique using plastic film holder. The radiographic length was also entered in proforma. The working length on endomotor of 0–2 mm short of radiographic length was considered positive accurate. If endomotor working length exceeded or short of more than 2 mm negative accuracy was labeled.

By following convenience sampling technique 124 patients were included in the study. Where Z-test was employed for proposed one tailed complex hypothesis testing mean and standard deviation were calculated for patient's age and working length for both methods. Frequency along with percentage was calculated for accuracy, type of tooth and gender. SPSS version 20 and Microsoft Office 2010 used for statistical analysis.

Results:

Among 124 patients, 69 (55.6%) were males and 55 (44.4%) were females with mean age of 33.60 ± 12.87 years. In these patients, 9 (7.3%) were central incisors, 6 (4.8%) were lateral incisors, 5 (4.0%) were canines, 9 (7.35%) were 1st premolars, 13 (10.5%) were 2nd premolars, 58 (46.8%) were 1st molars and 24 (19.4%) were 2nd molars. The mean radiographic working length was 21.71 ± 1.05 (95% confidence interval 21.52; 21.90), while on EndoMatic mean working length was 21.02 ± 1.28 with (95% CI: 20.79; 21.25). The accuracy between both working length apex locator and radiographic apex locator was determined by univariate analysis as represented in table 1.

Table 1 Accuracy of Working Length with respect to Gender and Type of Tooth

Factor	Accuracy	
	Positive	Negative
GENDER		
Male	54	15
Female	42	13
Working length endo-motor apex locator	96	28
Radiographic apex locator	87	37
TOOTH TYPE		
Central Incisor	8	1
Lateral Incisor	6	0
Canine	4	1
1 st Premolar	8	1
2 nd Premolar	5	8
1 st Molar	47	11
2 nd Molar	18	6

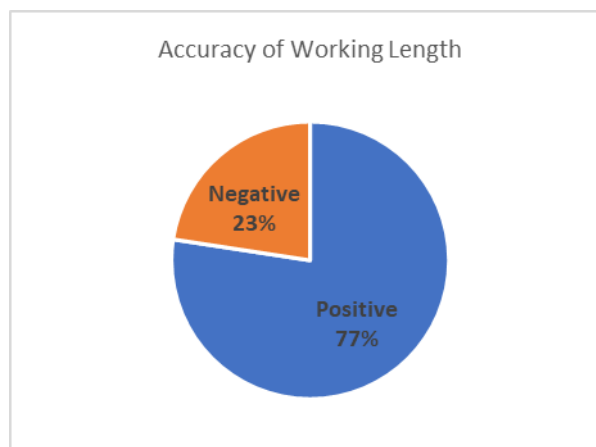
Working length accuracy was considered positive in 96 patients while negative in 28 patients. For path dimension calculations 87 cases were positive for radiographic apex locator and 37 cases were negative. We found comparative accuracy of 77 % of working length apex locator in terms of apical limit determination. Whereas, in case of radiographic apex locators 70 % accuracy was recorded. Cross tabulation of accuracy with respect to gender, tooth type is shown in Table 1. Further, non-significant difference between working length endo-motor apex locator and radio-graphic apex locator technique was noted.

Table.2. The comparative accuracy assessment of don-tonic therapeutic techniques.

don-tonic technique	Positive cases	Negative cases	Risk ratio	P- Value CI = 95 %
working length endo-motor apex locator	96	28	0.95	
radio-graphic apex locator	87	37	1.28	$P \geq 0.20$

Z= 1.29.

The comparative accuracy assessment of don-tonic therapeutic techniques suggests insignificant difference between subjected techniques accepting the null hypothesis ($P \geq 0.20$ at 95 % CI) Table.2. Accuracy of Working Length Endo-motor apex locator is shown graphically in fig 1.

Figure 1 Accuracy of Working Length Endo-motor apex locator

Discussion

The determination of working length is controversial in literature where some studies report positive results with working length determined by apex locator while other literature conveys opposite and find no significant difference between radiographs and apex locators^{13,14}. The purpose of this study was to evaluate the accuracy of determining working length in endomotor with built in apex locator and traditional radiographic method. These modern hybrid endomotors with built in apex locators are preferred among clinicians because of simplicity and relatively speedy work and maintenance of working length and apical end throughout the preparation¹⁵. In our present research minimum age of 12 years which is minimum age of root completion of permanent tooth.

EndoMatic is an endomotor from WOODPECKER which combines with the length measurement function and makes the endodontic treatment safer by displaying file position on the display screen and it stops rotating or reverse as the file touches apical limit. M3-Pro GOLD 2018 file system from United Dental Group (PRC) are NiTi files with features advocated by company are high flexibility, sharp cutting edge, controlled memory material, resistant to cyclic fatigue and non-cutting tip safeguarding the design.#12/02

path file of this series was used as most clinicians are preferring the rotary glide path preparation than manual¹⁶.

Study conducted by S.Y.A. Abidi, et al.¹⁷ showed accuracy of 88.5% with X smart dual endomotor while in our study 77% accuracy was obtained with EndoMatic endomotor. This could be due to previous studies used only single rooted teeth while current study was performed in multi rooted teeth with a larger sample size. Finding of current study are in agreement to the study of Schweiz¹⁸ that showed 77.2% accuracy; also our findings matches to the study conducted by Stavrianos¹⁹ which showed 70% to 97% accuracy in working length determination with apex locators. In literature, tooth type is reported as a factor influencing the accuracy of working length measurement. Our studies showed negative accuracy to be more prevalent in 2nd premolar followed by 1st molar which could be due to unpredictable anatomy and curvatures seen in 2nd premolars. This finding is also in agreement to study conducted by Elayouti²⁰ which showed working length measurement were inaccurate in 56% of premolars and 22% of molars. Studies^{21,22} also report decrease accuracy in wide apical foramina which can be due to difficulty in identifying the narrowest part of apex to calculate impedance, that why patients with open apex, resorption and traumatic root fractures were excluded from our study.

According to our results there was insignificant difference in their measurement, and both are similar in locating the apical extent while at the same time not affected by tooth type or gender, which could be due to increased sensitivity to apex locator or relatively small study sample. A study with a larger sample must be conducted to find any difference in accuracy.

Conclusion:

Within limitation of this study, it is concluded that hybrid endomotor with built in apex locators provide satisfactory control of apical limit of endodontic treatment and better time saving option, however radiographic confirmations remain the confirmatory length measurement tool to identify the dimension of canal and path obtained by endodontic instrument.

Conflict of Interest:

None.

Source of Funding:

None.

References:

1. Chybowski EA, Glickman GN, Patel Y, Fleury A, Solomon E, He J. Clinical Outcome of Non-Surgical Root Canal Treatment Using a Single-cone Technique with Endosequence Bioceramic Sealer: A Retrospective Analysis. *J Endod.* 2018 Jun;44(6):941-945. doi: 10.1016/j.joen.2018.02.019. Epub 2018 Mar 29. Erratum in: *J Endod.* 2018 Jul;44(7):1199. PMID: 29606401. <https://doi.org/10.1016/j.joen.2018.02.019>
2. Chatzopoulos GS, Koidou VP, Lunos S, Wolff LF. Implant and root canal treatment: Survival rates and factors associated with treatment outcome. *J Dent.* 2018 Apr;71:61-66. doi: 10.1016/j.jdent.2018.02.005. Epub 2018 Feb 27. PMID: 29499242. <https://doi.org/10.1016/j.jdent.2018.02.005>
3. AlRahabi MK. Evaluation of complications of root canal treatment performed by undergraduate dental students. *Libyan J Med.* 2017 Dec;12(1):1345582. doi: 10.1080/19932820.2017.1345582. PMID: 28678645; PMCID: PMC5508642. <https://doi.org/10.1080/19932820.2017.1345582>
4. Siqueira Junior JF, Rôças IDN, Marceliano-Alves MF, Pérez AR, Ricucci D. Unprepared root canal surface areas: causes, clinical implications, and therapeutic strategies. *Braz Oral Res.* 2018 Oct 18;32(suppl 1):e65. doi: 10.1590/1807-3107bor-2018.vol32.0065. PMID: 30365606. <https://doi.org/10.1590/1807-3107bor-2018.vol32.0065>
5. Sharma MC, Arora V. Determination of Working Length of Root Canal. *Med J Armed Forces India.* 2010 Jul;66(3):231-4. doi: 10.1016/S0377-1237(10)80044-9. Epub 2011 Jul 21. PMID: 27408308; PMCID: PMC4921252. [https://doi.org/10.1016/S0377-1237\(10\)80044-9](https://doi.org/10.1016/S0377-1237(10)80044-9)
6. Swapna DV, Krishna A, Patil AC, Rashmi K, Pai VS, Ranjini MA. Comparison of third generation versus fourth generation electronic apex locators in detecting apical constriction: An in vivo study. *J Conserv Dent.* 2015 Jul-Aug;18(4):288-91. doi: 10.4103/0972-0707.159726. PMID: 26180412; PMCID: PMC4502123. <https://doi.org/10.4103/0972-0707.159726>
7. Keratiotis G, Kournetas N, Agrafioti A, Kontakiotis EG. A comparative evaluation of two working length determination methods. *Aust Endod J.* 2019 Dec;45(3):331-336. doi: 10.1111/aej.12321. Epub 2018 Oct 22. PMID: 30350327. <https://doi.org/10.1111/aej.12321>
8. Simon S, Machtou P, Adams N, Tomson P, Lumley P. Apical limit and working length in endodontics. *Dent Update.* 2009 Apr;36(3):146-50, 153. doi: 10.12968/denu.2009.36.3.146. PMID: 19480102. <https://doi.org/10.12968/denu.2009.36.3.146>
9. Marigo L, Gervasi GL, Somma F, Squeo G, Castagnola R. Comparison of two electronic apex locators on human

- cadavers. *Clin Oral Investig.* 2016 Sep;20(7):1547-50. doi: 10.1007/s00784-015-1644-8. Epub 2015 Nov 4. PMID: 26531192. <https://doi.org/10.1007/s00784-015-1644-8>
10. Swapna DV, Krishna A, Patil AC, Rashmi K, Pai VS, Ranjini MA. Comparison of third generation versus fourth generation electronic apex locators in detecting apical constriction: An in vivo study. *J Conserv Dent.* 2015 Jul-Aug;18(4):288-91. doi: 10.4103/0972-0707.159726. PMID: 26180412; PMCID: PMC4502123. <https://doi.org/10.4103/0972-0707.159726>
11. Sharma MC, Arora V. Determination of Working Length of Root Canal. *Med J Armed Forces India.* 2010 Jul;66(3):231-4. doi: 10.1016/S0377-1237(10)80044-9. Epub 2011 Jul 21. PMID: 27408308; PMCID: PMC4921252. [https://doi.org/10.1016/S0377-1237\(10\)80044-9](https://doi.org/10.1016/S0377-1237(10)80044-9)
12. Yolagiden M, Ersahan S, Suyun G, Bilgec E, Aydin C. Comparison of Four Electronic Apex Locators in Detecting Working Length: An Ex Vivo Study. *J Contemp Dent Pract.* 2018 Dec 1;19(12):1427-1433. PMID: 30713168. <https://doi.org/10.5005/jp-journals-10024-2444>
13. Nekoofar MH, Ghandi MM, Hayes SJ, Dummer PM. The fundamental operating principles of electronic root canal length measurement devices. *Int Endod J.* 2006 Aug;39(8):595-609. doi: 10.1111/j.1365-2591.2006.01131.x. PMID: 16872454. <https://doi.org/10.1111/j.1365-2591.2006.01131.x>
14. Altenburger MJ, Cenik Y, Schirrmeister JF, Wrbas KT, Hellwig E. Combination of apex locator and endodontic motor for continuous length control during root canal treatment. *Int Endod J.* 2009 Apr;42(4):368-74. doi: 10.1111/j.1365-2591.2008.01535.x. Epub 2009 Feb 7. PMID: 19220512. <https://doi.org/10.1111/j.1365-2591.2008.01535.x>
15. Vasconcelos BC, Frota LM, Souza Tde A, Bernardes RA, Duarte MA. Evaluation of the maintenance of the apical limit during instrumentation with hybrid equipment in rotary and reciprocating modes. *J Endod.* 2015 May;41(5):682-5. doi: 10.1016/j.joen.2014.11.029. Epub 2015 Jan 13. PMID: 25595465. <https://doi.org/10.1016/j.joen.2014.11.029>
16. Keskin C, Sivas Yilmaz Ö, Inan U, Özdemir Ö. Postoperative pain after glide path preparation using manual, reciprocating and continuous rotary instruments: a randomized clinical trial. *Int Endod J.* 2019 May;52(5):579-587. doi: 10.1111/iej.13053. Epub 2018 Dec 31. PMID: 30536837. <https://doi.org/10.1111/iej.13053>
17. Abidi SYA, Azfar M, Nayab T, Shaukat A, Hasan M, Baig NN, Abid K. Accuracy of working length measurement with endo motor having built-in apex locator and comparison with periapical radiographs. *J Pak Med Assoc.* 2020 Mar;70(3):437-441. doi: 10.5455/JPMA.302464. PMID: 32207421. <https://doi.org/10.5455/JPMA.302464>
18. Pommer O. In-vitro-Vergleich der Wurzelkanallängenbestimmung mit Hilfe der Endometrie und der Röntgenmesssaufnahme [In vitro comparison of an electronic root canal length measuring device and the radiographic determination of working length]. *Schweiz Monatsschr Zahnmed.* 2001;111(10):1165-70. German. PMID: 11729819.
19. C. Stavrianos, L. Vasiliadis, I. Stavrianou and P. Kafas, 2007. Clinical Evaluation of the Accuracy of an Electronic Tooth Apex Locator. *Journal of Medical Sciences*, 7: 1369-1371. DOI: 10.3923/jms.2007.1369.1371 URL: <https://scialert.net/abstract/?doi=jms.2007.1369.1371> <https://doi.org/10.3923/jms.2007.1369.1371>
20. ElAyouti A, Weiger R, Löst C. Frequency of overinstrumentation with an acceptable radiographic working length. *J Endod.* 2001 Jan;27(1):49-52. doi: 10.1097/00004770-200101000-00018. PMID: 11487165. <https://doi.org/10.1097/00004770-200101000-00018>
21. Akisue E, Gratieri SD, Barletta FB, Caldeira CL, Graziotin-Soares R, Gavini G. Not all electronic foramen locators are accurate in teeth with enlarged apical foramina: an in vitro comparison of 5 brands. *J Endod.* 2014 Jan;40(1):109-12. doi: 10.1016/j.joen.2013.09.032. Epub 2013 Oct 25. PMID: 24332000. <https://doi.org/10.1016/j.joen.2013.09.032>
22. El Hachem R, Wassef E, Mokbel N, Abboud R, Zogheib C, El Osta N, Naaman A. Influence of the Maxillary Sinus on the Accuracy of the Root ZX Apex Locator: An Ex Vivo Study. *Dent J (Basel).* 2019 Jan 2;7(1):3. doi: 10.3390/dj7010003. PMID: 30609762; PMCID: PMC6473460. <https://doi.org/10.3390/dj7010003>