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ACCEPTANCE AND PRACTICALITY OF DIFFERENT WORKING LENGTH DETERMINATION METHODS IN PRIMARY TEETH: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Pulpectomy has been the most common treatment modality in pediatric patients and is also associated with dental anxiety and fear. Determining the working length (WL) is one of the crucial steps for a successful pulpectomy. A technique for determining working length must yield exact and reproducible results. The behaviour of children can influence the outcome of pulpectomy. Most of the methods used for working length determination can cause anxiety and are time-consuming.

Aim: To compare the acceptance, anxiety, behaviour, and time efficiency of different working length determination methods—tactile sensation, radiographic method, and electronic apex locator—in primary teeth for most effective clinical practices.

Materials and Methods: This randomized clinical study included 150 children aged 4–7 years requiring pulpectomy in primary molars. The children were randomly allocated into three groups (n = 50 each). Working length was determined using the tactile sensation method in Group 1, digital radiographic method in Group 2, and electronic apex locator (EAL) in Group 3. Children's anxiety and behaviour were assessed using the Venham Picture Test (VPT) and Frankl Behaviour Rating Scale (FBRS), respectively, at three stages: before treatment, during working length determination, and after treatment. The time required for working length determination was recorded. Data were statistically analyzed using appropriate nonparametric and parametric tests with a significance level set at $p < 0.05$.

Results: A significant difference was observed in VPT scores within and between groups, with higher anxiety levels noted during working length determination in the EAL group ($p < 0.05$). FBRS scores showed significant differences in distribution between groups but did not significantly influence the time required for working length determination. The mean time required was shortest for the tactile method (1.30 ± 0.13 minutes) and longest for the EAL method (3.00 ± 0.38 minutes), with statistically significant differences between all groups ($p < 0.05$).

Conclusion: In summary, while group type and VPT scores in different stages significantly influence the time taken in WL estimation, the results of FBRS do not have a noticeable effect.

Clinical Significance: Choosing time-efficient and comfortable working length determination methods may reduce anxiety and the need for behaviour guidance techniques in pediatric endodontic practice.

KEYWORDS: Working Length Determination, Dental Anxiety, Electronic Apex Locator, Pulpectomy, Child Dental Anxiety

INTRODUCTION

The most prevalent and unmet treatment needs in dental diseases are dental caries.1 Absence of parity in primary and permanent teeth leads to faster progress and beforehand pulpal involvement in primary teeth, requiring more frequent pulpectomy or pulp therapy.2,3 Till the physiological exfoliation process is completed, a satisfactory endodontic treatment in deciduous teeth is crucial for dentition maintenance.3,4 Pulpectomy helps in maintaining the integrity of the damaged tooth and thereby spacing required for a new tooth to grow, which also masquerades as self-esteem of the preschool children and helps in speech development, function, and esthetics5,6 Working length (WL) has been an important step for successful pulpectomy.7-10

Children's behaviour and behaviour management can affect the outcome of endodontic treatment in deciduous teeth. To ensure proper compliance, the dentist must provide safety, swiftness and ease during treatment.11 Dental Anxiety and Uncooperative behaviour are prevalent in children, ranging from 14.6–39%12,13 and 8.9–25.2%14-16 respectively. That depends on the duration and the type of dental procedure.17,18 Apart from behavioural expectations in children, anatomical differences of the root canals produced by atypical resorption reduce the efficacy of endodontic treatment.19

Various techniques can be used to get an accurate working length, but all come with their limitations. The most widely used and attainable techniques are the Radiographic and Electronic Apex Locator (EAL) method, 7,8,10,20-22 but their disadvantage is that they can't be used in very small children or special children, as they require cooperation, as well it is also time-consuming. Another method is the tactile sensation method, which doesn't require the introduction of any extra instruments or machines but has dichotomous data. 7,23-25 This study uniquely evaluates working length determination

methods in primary teeth by integrating procedural time with validated assessments of child anxiety and behaviour. Moving beyond accuracy alone, the study provides clinically relevant evidence on the acceptance and practical implications of these methods, offering a patient-cantered framework to optimize efficiency and minimize the need for behaviour guidance techniques in pediatric endodontics.

Material and methodology:

Ethical approval and informed consent:

This study was conducted in the Department of Pediatric and Preventive dentistry, College of Dental Sciences and Research Centre, Ahmedabad, from March 2024 to July 2024. This study was approved by the Institute Ethical Committee under approval number (CDSRC/IEC/2024/26) Written informed consent was obtained from all participants prior to participation.

Sample size calculation, randomization and allocation: Sample size was calculated using the formula n = [DEFF*Np(1-p)]/ [(d2/Z21-α/2*(N-1)+p*(1-p)], confidence interval 95%. A total of 150 children were selected. All investigators and participants were blinded to the patient allocation. The children were divided via simple randomisation with a random number table into 3 groups (Group 1, Group 2, and Group 3), consisting of 50 children each. In groups 1, 2, and 3, root canals were instrumented using the Tactile sensation, Digital Radiographic working length and EAL (Propex Pixi, Dentsply Maillefer), respectively.

Inclusion and Exclusion criteria: Children with Pulpal involvement of lower molars and 2/3 remaining roots, and Children with no history of dental treatment and no previous experience of intraoral injections were included in the study. Children with special healthcare needs, rampant caries or developmental anomalies and children with limited or lacking cooperative abilities were excluded from the study.

Steps of Study: (Image I)

After ethical committee approval, informed consent was obtained from the guardian/parent accompanying the pediatric patient. The pulpectomy procedure was carried out in two visits by a single operator. The first visit consisted of administration of local anaesthesia, Isolation (Rubber Dam), Access Cavity Preparation, Pulp Extirpation, drying using paper points and WL determination. In the second visit, Biomechanical preparation, Obturation and Final restoration were done. During the first visit of pulpectomy, the anxiety and behaviour of the child were assessed using the Venham Picture Test (VPT) and Frankl Behaviour Rating scale (FBRS), respectively into three phases: (1) Phase 1: 5 minutes before the start of the treatment. (2) Phase 2: During the working length determination (3) Phase 3: After Treatment. WL determination time was calculated by a trained dental assistant using a stopwatch. Instrumentation time from the start of inserting the file after pulp extirpation to the definite WL is recorded.

Group 1 (Tactile Method): (Image 2) After preparing a flat reference point to allow for precise positioning of the file, the K-file was used for working length determination. The size of the K-file used was such that passive binding occurred as the file approached the estimated length. After that, with a ruler Tentative working length was recorded.

Group 2 (Digital Radiographic Method): The Exact working length of the teeth was determined using Grossman's method.26,27

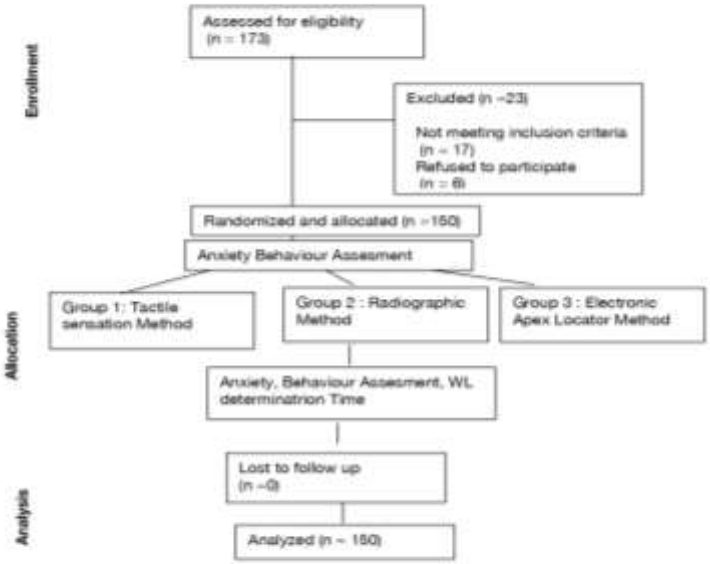

Image 1: Flowchart of study design

Image 2: Clinical photograph

Group 3(EAL): (Image 3) In each tooth, electronic root length was measured by the Propex Pixi (Dentsply Maillefer) apex locator following the manufacturer's instructions. If the readings were stable for at least 5 seconds, the electronic root canal length was measured using the 0.5-mm precision endodontic ruler, considering the actual root length.
The data was obtained and entered into Microsoft Excel version 13. The data were subjected to statistical analysis using IBM Statistical Package for Social Science version 21. For the continuous variable (Time), Mean and Standard Deviation were obtained. For categorical variable VPT, Grade and FBRS Frequency and percentage were obtained. For comparison between the VPT Grade, FBRS Grade within different time intervals and between different groups Kruskal-Wallis Test was applied. For comparison of the Time taken between groups, Analysis of Variance with Post Hoc Tukey Test was applied. All the statistical tests were applied keeping a confidence interval at 95% and ($p<0.05$) was considered to be statistically significant.

Image 3: Clinical photograph

RESULTS
The scores for the Venham Picture Test (VPT) are mixed. The VPT score "Before Treatment" does not have a significant effect on WL estimation time (estimate = −0.05791, SE = 0.0492, t = −1.1764, p = 0.241). However, in WL determination, higher VPT scores significantly increase the time taken (estimate = 0.09306, SE = 0.0413, t = 2.2554, p = 0.026). Higher scores for VPT after treatment relate to a significant reduction in the time taken (estimate = −0.12786, SE = 0.0450, t = −2.8426, p = 0.005). (Table 1) Within and Between Group Comparison of the VPT Grade was found to be statistically significant ($p<0.05$). (Table 2)
The scores of the FBRS do not seem to affect the time taken for WL estimation at any stage. (statistically non-significant) When within and between Group comparison of the FBRS Grade was done, it was observed that the difference in proportion for within and between groups of the FBRS Grade was found to be statistically significant ($p<0.05$). (Table 3)
When the Comparison of the Time taken for WL Estimation in three groups was evaluated, it was observed that the Mean time taken for the Tactile Group was 1.30 ± 0.139, for the Radiographic Group was 2.40 ± 0.391 and for the Apex Locator Group was 3.00 ± 0.387. This difference in Mean was found to be statistically significant ($p<0.05$). When pairwise comparison of the Time taken for WL Estimation was done, it was observed that the difference in Mean was statistically significant between all the comparison groups ($p<0.05$) (Table 4)

Table 1: Correlation between the Time Taken for Working Length Estimation VPT and FBRS at Different time intervals

Estimate	SE	t		
Intercept [a]	1.73523	0.2527	6.8668	< .001
Groups:				
Radiographic – Tactile	1.14435	0.0685	16.7039	< .001
Apex locator – Tactile	1.62412	0.0770	21.1025	< .001
VPT Before Treatment	-0.05791	0.0492	-1.1764	0.241
VPT During WL detemination	0.09306	0.0413	2.2554	0.026
VPT After Treatment	-0.12786	0.0450	-2.8426	0.005
FBRS Before Treatment	-0.00740	0.0896	-0.0826	0.934
FBRS During WL determination	-0.07362	0.0538	-1.3678	0.174
FBRS After Treatment	-0.03466	0.0759	-0.4565	0.649

Table 2: Within and Between Group Comparison of the VPT Grade

VPT Grade			Time Interval				p Value
			Before Treatment	During WL Determination	After Treatment	Total	
Group 1	1	N	7	1	18	26	0.001
		%	4.7 %	0.7 %	12.0 %	17.3 %	
	2	N	23	16	28	67	
		%	15.3 %	10.7 %	18.7 %	44.7 %	
	3	N	18	19	4	41	
		%	12.0 %	12.7 %	2.7 %	27.3 %	
	4	N	2	12	0	14	
		%	1.3 %	8.0 %	0.0 %	9.3 %	
	5	N	0	2	0	2	
		%	0.0 %	1.3 %	0.0 %	1.3 %	
	Total	N	50	50	50	150	
		%	33.3 %	33.3 %	33.3 %	100.0 %	
Group 2	1	N	1	0	5	6	0.001
		%	0.7 %	0.0 %	3.3 %	4.0 %	
	2	N	20	6	31	57	
		%	13.3 %	4.0 %	20.7 %	38.0 %	
	3	N	19	21	12	52	
		%	12.7 %	14.0 %	8.0 %	34.7 %	
	4	N	10	16	2	28	
		%	6.7 %	10.7 %	1.3 %	18.7 %	
	5	N	0	7	0	7	
		%	0.0 %	4.7 %	0.0 %	4.7 %	
	Total	N	50	50	50	150	
		%	33.3 %	33.3 %	33.3 %	100.0 %	
Group 3	1	N	7	0	8	15	0.001
		%	4.7 %	0.0 %	5.3 %	10.0 %	
	2	N	21	1	33	55	
		%	14.0 %	0.7 %	22.0 %	36.7 %	
	3	N	21	20	9	50	
		%	14.0 %	13.3 %	6.0 %	33.3 %	
	4	N	1	22	0	23	

		%	0.7 %	14.7 %	0.0 %	15.3 %	
	5	N	0	6	0	6	
		%	0.0 %	4.0 %	0.0 %	4.0 %	
	6	N	0	1	0	1	
		%	0.0 %	0.7 %	0.0 %	0.7 %	
	Total	N	50	50	50	150	
		%	33.3 %	33.3 %	33.3 %	100.0 %	
p Value			0.001	0.001	0.001		

Table 3: Within and between Group comparison of the FBRS Grade

FBRS			Time Interval			Total	p Value
			Before Treatment	During WL Determination	After Treatment		
Group 1	Negative	n	1	9	1	11	0.001
		%	0.7 %	6.0 %	0.7 %	7.3 %	
	Positive	n	41	38	25	104	
		%	27.3 %	25.3 %	16.7 %	69.3 %	
	Definitely Positive	n	8	3	24	35	
		%	5.3 %	2.0 %	16.0 %	23.3 %	
	Total	n	50	50	50	150	
		%	33.3 %	33.3 %	33.3 %	100.0 %	
Group 2	Definitely Negative	n	0	1	0	1	0.001
		%	0.0 %	0.7 %	0.0 %	0.7 %	
	Negative	n	6	5	1	12	
		%	4.0 %	3.3 %	0.7 %	8.0 %	
	Positive	n	35	36	33	104	
		%	23.3 %	24.0 %	22.0 %	69.3 %	
	Definitely Positive	n	9	8	16	33	
		%	6.0 %	5.3 %	10.7 %	22.0 %	
	Total	n	50	50	50	150	
		%	33.3 %	33.3 %	33.3 %	100.0 %	
Group 3	Definitely Negative	n	0	2	0	2	0.001
		%	0.0 %	1.3 %	0.0 %	1.3 %	
	Negative	n	0	21	0	21	
		%	0.0 %	14.0 %	0.0 %	14.0 %	
	Positive	n	43	27	43	113	
		%	28.7 %	18.0 %	28.7 %	75.3 %	
	Definitely Positive	n	7	0	7	14	
		%	4.7 %	0.0 %	4.7 %	9.3 %	
	Total	n	50	50	50	150	
		%	33.3 %	33.3 %	33.3 %	100.0 %	
p Value			0.001	0.001	0.001		

Table 4: Comparison of the Time taken for WL Estimation in three groups

	Groups	N	Mean	SD	SE	F	p
Time Taken for WL estimation	Tactile	50	1.3	0.139	0.0196	539	< .001
	Radiographic	50	2.4	0.391	0.0553		
	Apex locator	50	3	0.387	0.0548		

DISCUSSION

To minimise the periapical injury and possible damage to erupting permanent teeth, accurate root canal length plays a crucial role in root canal treatment of primary teeth. 27No ideal method of WL determination is far from controversy. In this study, we have compared the Tactile, Digital Radiographic and EAL methods. Radiography and EALs are commonly used techniques, but the techniques have their disadvantages and limitations, such as limited access to the mouths of young children, poor patient cooperation, increased appointment time, and exposing the children to ionising radiation. Moreover,

the technique is sensitive and subject to operator interpretation and quality issues such as distortion and magnification, in the case of the radiographic method. 28 Among the factors that could trigger dental anxiety and uncooperative behaviour, some are general fears, maternal characteristics, child-dentist relationship, previous dental and medical experience and personality traits of dentist and child. 29,30 For that reason, we have selected children with no previous history of dental treatment and no previous experience of intraoral injections. Among the widely available tests for anxiety rating and the most widely used and acceptable scales is the VPT scale.31-33 The gold standard for classifying the behaviour of the child in the dental operatory is Frankl's Behavioural Rating Scale (FBRS), which is widely used and accepted by pediatric dentists.34

The result of this study suggests that VPT and FBRS were both higher in the EAL method during WL determination. This suggests that EAL can cause higher anxiety and also requires more time. The introduction of new material can increase anxiety and a behaviour change.35 The highest VPT score was less in the tactile method, as it doesn't require introduction to any new instruments; that's why it may cause less anxiety and positive behaviour. The result of the efficacy of tactile sensation shows conflicting evidences. Studies suggest that there is no statistically significant difference between tactile sensation, EAL, or radiographic methods.24,25,36 On the contrary, some suggest that it doesn't show as accurate results compared to EAL.7,22,37 The mean score for time taken for WL determination is highest in EAL (3 min) and lowest in the tactile method (1.3 min). Studies suggest that an increase in operative time has a negative effect on a child's anxiety and behaviour38, and also, short appointment time establishes a good rapport with the pediatric dentist and the self-confidence of a child.39 Aminabadi et al.40 and Davidovich et al.41 stated that as the treatment time increases, significant deterioration of behaviour in younger children was noted. Studies suggest that total appointment time for pediatric dental patients for any treatment should not be greater than 30 min.42 Considering that in this study, the procedure was conducted in two visits. A pediatric Dentist must establish good communication, empathy and a trusting relationship with short appointment duration, step-wise treatment and effective treatment procedure.17 From a clinical standpoint, the present findings emphasize the need for pediatric dentists to balance accuracy with chairside efficiency and child acceptance when selecting a working length determination method. Although electronic apex locators are widely regarded as reliable, their longer procedural time and greater association with child anxiety observed in this study suggest that they may not always be the most practical option for young or anxious patients. Prolonged working length determination can adversely affect child cooperation, thereby increasing the need for behaviour guidance techniques. Consequently, clinicians should individualize method selection based on the child's behavioural profile, anxiety level, and ability to cooperate, rather than relying on a single technique for all cases. Less time-consuming and more comfortable methods may offer practical advantages in pediatric endodontics, particularly when used judiciously or as adjuncts, to enhance treatment efficiency, patient comfort, and overall clinical outcomes.

The limitation of this study is a small sample size, same observer as all practitioners may perceive behaviour exhibited by children differently and also tolerate children's behaviour differently. 43,44 As the tactile sensation method offers greater speed and ease during root canal treatment, its clinical utility warrants further investigation through well-designed clinical studies. Additionally, the development of AI-based software or regression models may enhance clinical efficiency and treatment outcomes while reducing chairside time.

CONCLUSION

Within the limitations of this study, the working length determination method and children's anxiety levels significantly influenced the time required for working length estimation, whereas child behaviour did not show a significant effect. Although electronic apex locators are widely used, they required the longest procedural time and were associated with higher anxiety. In contrast, the tactile sensation method showed shorter working length determination time and better acceptance. These findings highlight the importance of selecting a working length determination method that balances efficiency, accuracy, patient comfort, and minimal reliance on behaviour guidance techniques in pediatric endodontic practice.

Author Contributions:

Conceptualization and study design was done by Author 1 & Author 2. All the Clinical procedures and data collection was done by Author 1. Statistical analysis was done or helped by Author 2 / Statistician. Manuscript drafting was done by Author 1. Critical revision of the manuscript was conducted by Author 1 & Author 2.

Conflict of Interest:

The authors declare that there are no conflicts of interest related to this study.

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