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Assessment of Distortion of Radiovisiographical Tooth Length Compared to Actual Tooth Length: In-Vivo and In-Vitro Study

Md Ali Asgor Moral[1], Rozina Akter[2], Mir Md Mofazzal Hossain[3], Md Helal Uddin[4]

[1]Chairman and Dean, Department of Conservative Dentistry and Endodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh
[2]PhD Fellow, Department of Conservative Dentistry and Endodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh
[3]Assistant Professor, Department of Conservative Dentistry and Endodontics, Dhaka Dental College, Dhaka, Bangladesh
[4]Assistant Professor, Department of Orthodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

ABSTRACT

Background: Determination of appropriate or exact working length measurement with radiovisiography (RVG) during root canal treatment (RCT) is an essential for the long-term success. As, there are several controversies with the distortion of RVG image in assessing the working tooth length (WTL) during RCT compared to actual tooth length (ATL). So, this study was aimed to assess the frequency of distortion of radiovisiographical tooth length (RTL) compared to actual tooth length (ATL).

Methods: An analytical (in-vivo and in-vitro) study was conducted at Department of Conservative Dentistry and Endodontics, BSMMU. The patient indicated for extraction purpose of orthodontic treatment was considered as the study population. Human premolar teeth (n=20) were selected as study sample by purposive sampling technique which met the inclusion and exclusion criteria. The RTL measurements were carried out with RVG images before and after tooth extraction (in-vivo and in-vitro setting). Then the ATL measurements of extracted tooth samples were carried out with both Inch Architectural Scale Ruler and Endodontic Ruler individually three concordant times.

Statistical analysis: The data was analyzed using T test and presented in frequency and percentages with tables.

Results: For 95% of study samples, the differences from actual and radiovisiographical tooth length were <0.5 mm. Total 19 tooth samples (out of 20) showed acceptable level of coincidence except one sample showed non-acceptable level of coincidence. There was no sample revealed exact level of coincidence. There was a significant difference between the distortion category; yes (95%)/ no (5%) (*P* 0.001). The radiovisiological tooth lengths among all samples were same in both in-vivo and in-vitro setting. Study results also revealed the average distortion of RTL to ATL was 2.61±0.97 mm when RVG was done without using RVG sensor positioner.

Conclusion: RVG tooth length images exhibited no distortion with the exact anatomical tooth lengths when the RTL was carried out with RVG sensor positioner. It's recommended that to overcome the RVG image distortion, the RTL measurement ought to be carried out with RVG sensor positioner allowing RVG sensor/film parallel to long axis of tooth; RVG beam position perpendicular (90^0) to long axis of tooth.

Keyword: Radiovisiological Distortion, Radiovisiological Tooth Length, Actual Tooth Length, RVG Sensor Positioner

INTRODUCTION

An accurate and a reproducible working length is an important factor in root canal treatment.[1] The success rate of conventional RCT must be correlated with the length of the final root canal filling.[2] Removal of pulp, necrotic tissues, and microorganisms is essential from the canals before obturation which consequently is dependent on the determination of the exact working length.[3] Hence, the procedure for the calculation of working length should be performed by the use of several radiographical techniques that have been proven to give precise results and simultaneously being practical.[4] There are various methods of determining the working length, but the time of the 20th century, radiovisiographs has been recommended to dentistry as working length measurement technique.[4,5]

Accurate tooth length measurement with RVG can in turn result in the ability to decide on proper diagnosis for working length measurement.[5,6] But, there are several types of drawbacks of radiovigiography such as distortion or magnification of tooth length.[7] So, the distortion of radiovisiographical image is important in aspects of the defining a good radiography that directly affect the quality of the RVG to use in working length measurement procedure.[8] As radiovisiography comprises accurate location of root apices and it is easy to interpretation.[9] It also provides a image and represent real position of apical region. But it is claimed that radiovisiographs are subjected to distortion and magnification.[10,11,12]

Although, the advantage of RVG is that there is a 60% radiation dose reduction and production of an instant image, but which can be modified or distorted.[13,14] It becomes even more difficult to establish correct working length with radiography.[15,16] So, this study aim was to assess the distortion of radiovisiographical tooth length by comparative measurement with actual tooth length as well as to determine the percentage of distortion of radiovisiography.

METHODS

A cross sectional analytical study (in-vivo and in-vitro study) among the patients who was advised for tooth extraction purpose of orthodontic treatment. Permanent human premolar tooth (n=20) which met the inclusion criteria were taken as sample of the study. Purposive sampling technique was used to select the samples. An individual patient's data and including case history were recorded with a check list. Before tooth extraction, the tooth sample was imaged by the RVG for measurement of the radiovisiographical tooth length. After the tooth extraction, radivisiographical tooth length was also measured. Then the actual tooth length (A-L) measurements were carried out with both Inch Architectural Scale Ruler and Endodontic Ruler individually three concordant times. The level of

coincidence/ radiological distortion index was used according to Bashar et al., 2017.[4] Data were collected with the help of a pretested semi-structured check list.

The level of coincidence/ distortion index of radiovisiological image with actual tooth length[4]

Level of coincidence	Interpretation	Code no
Exact coincidence	Zero difference between the value obtained by radiovisiological tooth length and the actual tooth length (mm)	1
Acceptable coincidence	0.5 mm or less than 0.5 mm (≤ 0.5 mm) decrease in radiovisiological tooth length when compared with the actual tooth length value (mm)	2
Non-acceptable coincidence	more than 0.5 mm short or over of radiovisiological tooth length than the ATL (mm)	3

ILLUSTRATIONS

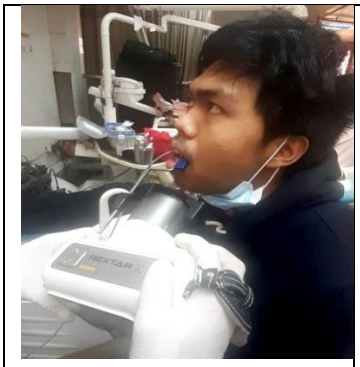


Fig 1: RVG imaging (in –vivo setting) with RVG sensor positioner

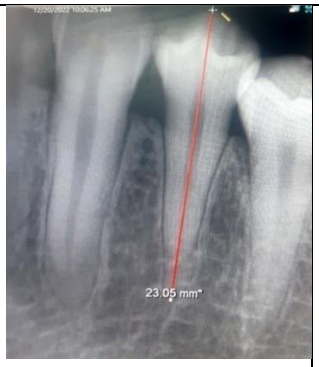


Fig 2: Tooth length measurement with RVG (lower premolar)

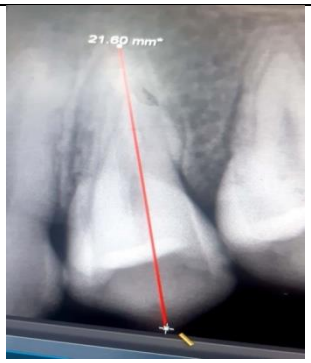


Fig 3: Tooth length measurement with RVG (upper premolar)

Fig 4: Extracted tooth samples

Fig 5: Prepared tooth samples after cleaning

Fig 6: Tooth sample in acrylic base and RVG sensor positioner

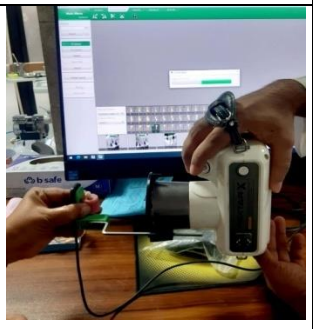


Fig 7: RVG imaging (in-vitro setting) with RVG sensor positioner

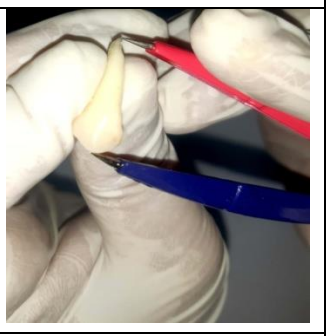
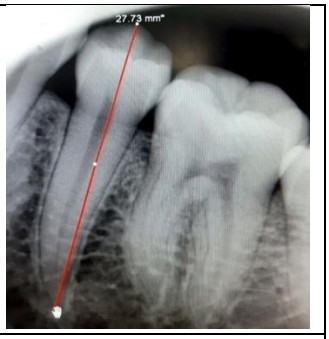


Fig 8: Actual tooth length measurement

			
Fig 9: Actual tooth length measurement	**Fig 10: Actual tooth length evaluation with Endodontic Ruler**	**Fig 11: Actual tooth length evaluation with Inch Architectural Scale Ruler**	**Fig 12: RVG imaging of tooth sample without RVG sensor positioner**

RESULTS

TABLE 1 Distribution of actual tooth length, tooth length with RVG (in-vivo and in-vitro) and difference from actual and RVG tooth length (mm) (in-vitro) (n = 20).

Sample No.	ATL (mm)	RTL (in-vivo) (mm)	RTL (in-vitro) (mm)	Difference from ATL and RTL (mm) (in-vivo)	Difference from ATL and RTL (mm) (in-vitro)
1	21.10	21.60	21.60	.50	.50
2	22.75	23.05	23.05	.30	.30
3	23.00	23.33	23.33	.33	.33
4	23.50	23.02	23.00	.52	.50
5	22.50	23.00	23.00	.50	.50
6	21.75	22.00	22.00	.25	.25
7	22.50	23.00	23.00	.50	.50
8	23.50	24.00	24.00	.50	.50
9	23.00	23.18	23.18	.18	.18
10	22.00	22.75	22.75	.75	.75
11	21.00	21.50	21.50	.50	.50
12	22.25	22.75	22.75	.25	.25
13	23.25	23.50	23.50	.25	.25
14	22.75	23.00	23.00	.25	.25
15	23.25	22.75	22.75	.50	.50
16	22.00	22.00	22.00	.00	.00
17	23.25	23.75	23.75	.50	.50
18	21.75	22.25	22.25	.50	.50
19	22.50	23.00	23.00	.50	.50
20	23.50	23.05	23.05	.45	.45

In the TABLE 1, for 19 study samples, the differences between ATL and RTL were less than 0.5 mm except for one sample; the difference between ATL and RTL was more than 0.5 mm. The RTL were same among all samples both in-vivo and in-vitro setting.

TABLE 2: Distribution of level of coincidence of actual tooth length with radivisiographical tooth length of the study samples (n = 20).

Sample No.	Level of coincidence	Code No.
1	Acceptable	2
2	Acceptable	2
3	Acceptable	2
4	Acceptable	2
5	Acceptable	2
6	Acceptable	2
7	Acceptable	2
8	Acceptable	2
9	Acceptable	2
10	Non-acceptable	3
11	Acceptable	2
12	Acceptable	2
13	Acceptable	2
14	Acceptable	2
15	Acceptable	2
16	Acceptable	2
17	Acceptable	2
18	Acceptable	2
19	Acceptable	2
20	Acceptable	2

Exact = 1, Acceptable = 2 and Non-acceptable = 3

TABLE 2 demonstrated the distribution of level of coincidence of actual tooth length with radivisiographical toot length of the study samples. Here, 19 study samples out of 20 samples showed the acceptable level of coincidence except one sample showed the non-acceptable level of coincidence. There was no sample showed exact level of coincidence.

TABLE 3 Frequency and percentage of distortion of RVG tooth length among the study samples (n=20)

Distortion category	Number/frequency (n)	Prevalence/ percentage of distortion of RVG images among total samples (%)	*P* value
Yes	1	5%	**0.001***
No	19	95%	

P ≤ 0.05 is considered as statistically significant.

The TABLE 3 indicated that the prevalence of distortion of RVG tooth length to ATL among total samples was 5%. There was a significant difference between the distortion category; yes/no (*P* 0.001).

TABLE 4 Distribution of actual tooth length, tooth length with RVG (in-vivo and in-vitro) and difference between actual and RVG tooth length without RVG sensor positioner (mm) (in-vitro) (n = 20)

Sample No.	Actual tooth length (mm)	RVG tooth length with sensor positioner (in-vitro) (mm)	RVG tooth length without sensor positioner (in-vitro) (mm)	Difference between ATL and RTL without Sensor positioner (mm)	Mean value of difference between ATL and RTL without Sensor positioner (mm)	Standard deviation of difference between ATL and RTL without Sensor positioner (mm)
1	21.10	21.60	23.00	1.80	**2.61**	**±0.97**
2	22.75	23.05	24.50	1.75		
3	23.00	23.33	27.73	4.73		
4	23.50	23.02	25.00	1.50		
5	22.50	23.00	25.32	2.82		
6	21.75	22.00	23.25	1.50		
7	22.50	23.00	23.75	1.25		
8	23.50	24.00	26.55	2.95		
9	23.00	23.18	25.25	2.25		
10	22.00	22.75	23.75	1.75		
11	21.00	21.50	24.50	3.50		
12	22.25	22.75	24.20	1.95		
13	23.25	23.50	25.75	2.50		
14	22.75	23.00	26.00	3.25		
15	23.25	22.75	25.75	2.50		
16	22.00	22.00	24.50	2.50		
17	23.25	23.75	27.00	3.75		
18	21.75	22.25	25.25	3.50		
19	22.50	23.00	24.75	2.25		
20	23.50	23.05	27.75	4.25		

TABLE 4 revealed that the average distortion of radiovisiographical tooth length compared to actual tooth length was 2.61±0.97 mm if RVG is done without parallel technique; the long axis of tooth is parallel to RVG sensor with RVG sensor holder/ positioner.

DISCUSSION

Previous several studies revealed that the image of tooth with RVG is susceptible to be distorted, unsharp and unclear representation.[3,4] But, this study results revealed that there was no distortion of radiovisiographical tooth length measurement compared to actual tooth length measurement.

Radivisiographical image as a pre and post operative screening radiograph and it is widely available and economical. Many studies were carried out to know the reliability of RVG other than measurement

technique of toot length.[5,6] A previous research compared different intra-oral radiographs to assess the working length measurement.[6] Study investigated the reliability of RVG to determine the tooth length and found that the methods were not reliable to identify the exact working tooth length.[7] But, study findings discussed above were dissimilar to this current study findings.

In addition, in our study, there was about 2.61 mm distortion between ravisiographical tooth ength and actual tooth length. This difference occurred due to position of sensor of RVG. When RVG sensor positioner with parallel technique to long axis of tooth length was not used, then distortion occurs. In the present study, the tooth length measured from RVG images showed no statistically significant difference from actual tooth lengths and these measurement provided improved clarity and accuracy in both in-vivo and in-vitro settings.

RVG is a imaging technique that has been regarded as a dependable diagnostic modality in recent dental practice as it overcomes numerous shortcomings of conventional radiographic techniques by giving precise details.[7,8] Images with good resolution and lack of superimposition are some of the additional benefits of RVG imaging. Different results exist in the literature regarding the accuracy of the measurements obtained from RVG images. Few studies report the underestimations of the measurements, and some claim proposed that the measurements match the actual measurements. A previous study was carried out to know the accuracy of RVG in measuring the tooth lengths of only single rooted premolar teeth, in the present study the two rooted premolar tooth length were also analyzed.[8] In the present study, in comparison with actual lengths, RVG lengths were relatively accurate and almost not distorted.

Every clinician or dental practitioner must be able to take good quality of RVG image. The paralleling technique is considered to be the best way to take RVG and when used correctly, it should produce reliable images with no distortion.[8] With this technique, the film is placed parallel to the long axis of a tooth, allowing the X-ray to be focused perpendicular to the long axis of the tooth. The patient is seated upright in the dental chair and should remove any removable dental appliances, glasses or jewelry that could interfere with the RVG beam.[9,10] So, it is expected that this study provides a background data of the scientific evidence regards the distortion or deviation of the radivisiographical tooth length measurement compared to actual tooth length.

CONCLUSION

RVG tooth length images exhibited no distortion with the exact anatomical tooth lengths when the RTL was carried out with RVG sensor positioner.

RECOMMENDATION

It's recommended that to overcome the RVG image distortion, the RTL measurement ought to be carried out with RVG sensor positioner allowing RVG sensor/film parallel to long axis of tooth; RVG beam position perpendicular (90^0) to long axis of tooth

LIMITATIONS

There are various methods of determining the working tooth length such as OPG, Conventional intra-oral X-ray and CBCT have not included in this study.

ACKNOWLEDGMENTS

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