Conventional Radiography Versus Radiovisiography System To Estimate Working Length: An In Vitro Study

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Abstract

Aim: The purpose of this study was to compare the working length determination done using two methods, namely,conventional radiography (IOPA)and radiovisiography (Kodak RVG 5100).

Materials &Method: In this experiment, to determine the working length, 30 molar teeth were selected and each tooth was subjected to two methods of the working length determination.

Results: There is no significant difference between conventional radiography,and radiovisiography in the accuracy of working length determination.

Conclusion: This in vitro study suggests the radiovisiography is in a high correlation with conventional radiograph in root length determination.Long term follow up studies is necessary to evaluate post-operative success comparing these methods of working length determination in endodontics.

Keywords: Working length, Radiography, Radiovisiography.

Introduction

One of the major difficulties in endodontic treatment has always been identification of the biological length of the root canal system. It is important to get precise and reproducible working length in root canal treatment[1]. Working length establishes the apical extent of the canal preparation and apical stop. Precise working length is essential if damage to the root apices and periapical tissues during instrumentation and obturation procedures is to be avoided.

Traditional method for estimating working length, include radiography, anatomical averages and tactile sensation. All of these methods have limitation and do not allow precise localization of apical constriction. In recent years to overcome the limitation offered by traditional methods new techniques have been introduced. Thus in addition to radiographic measurements, digital radiography has become increasingly important. Radiovisiography, which is the most recently introduced method and is fast gaining widespread popularity[6]. The advantage of radiovisiography is that there is a 60% radiation dose reduction and production of an instant image which is enhanceable and modifiable.

Materials & Method

The materials and techniques tested in this studies are radiovisiography unit (Kodak RVG 5100), X-ray unit (Satelac), X-ray film (E Speed, Kodak). Thirty molar teeth indicated for extraction were taken for the study.

After careful extraction of the teeth, they were placed in 5.25% sodium hypochlorite solution to remove any remnants of periodontal tissue from the apical portion of the root surface. The teeth were screened and X-rays were taken. If any of the following were noted, then those teeth were not included in the study.

- Incompletely formed apex
- Evident root fracture
- Dilacerated root
- Pulpal calcification.

Fig.[1]Sample

Method of Collection of Data

The pulp chamber was accessed; root canals were located and irrigated with 5.25% sodium hypochlorite solution. Care was taken to maintain the standardization between samples while recording working length measurement in both techniques, conventional radiography and radiovisiography.Tooth positioner and paralleling technique were used for standardization during exposure with radiography and radiovisiography. A constant distance of 3 inches was maintained between the cone head of the X-ray unit and the tooth positioner during radiographical and radiovisiographical methods for all the samples[7].

Fig.[2] Access Cavity Preparation With Airotor Handpiece

Intraoral Periapical Radiograpy (IOPA)

The length of the root was measured on

the preoperative radiograph, from the reference points considered to the root apex, and 1 mm substracted from this length to avoid distortion and magnification errors (safety allowance).The comparison was made with the radiograph with the stainless steel 15 size K-file(Densply India Pvt. Ltd., India) is then inserted into the canals.After this the difference between the end of the instrument and the end of the root was measured on the radiograph and this amount was added/substracted to the original measured length. From this reading, substract 1mm using endogauge and the final WL was established.

Fig.[3] Satelec X-ray Unit

Fig. [4] X-ray Film Placed In Platform

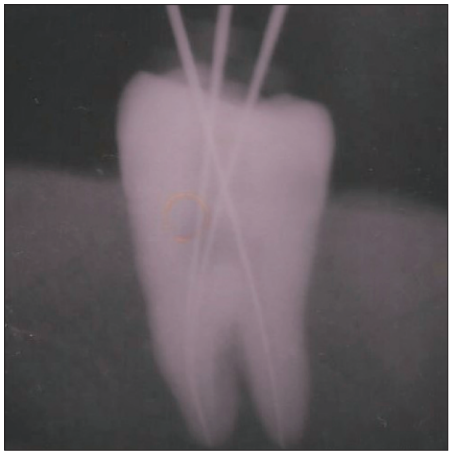

Fig. [5] Working Length As Seen In Conventional Radiograph

Digital Radiovisiography

The radiographic image by RVG(Kodak 5100) with CCD sensor was taken by using the sensor as x-ray film and the imaging technique is as same as conventional radiography.But the exposure time is less compared to IOPA radiographic technique.The measuring options were available in the RVG software as each canal is measured in different colours and the calibrations are noted. Likewise IOPA technique, the difference between the end of the instrument and the end of the root was measured and this amount was added/substracted to the original measured length by comparing the preoperative RVG image of the tooth.

Fig. [6] Kodak 5100 Rvg System

Fig.[7] Rvg Sensor Placed In Platform

Fig.[8] Working Length As Seen In RVG

Control

The actual length of the tooth was determined using the same reference point and the same file used previously. The file was placed into the canal until the tip was visualized from a tangential angle at the apical exit. The stopper was set at the occlusal reference point and the file removed and set aside. The true length was determined for each tooth using a millimeter scale. Measurement was read to the nearest 0.5 mm. The actual working length was established by subtracting 0.5 mm from the true canal length.

Fig.[9] File Tip Seen At Apex

The working length readings recorded were tabulated and the values were subjected to statistical analysis.

Results & Analysis

Working length in 30 adult mandibular molar teeth indicated for extraction were measured by both

1.Conventional Radiography. Clconv

2. Radiovisiography methodCLrvg

True canal length CLtrue was previously determined by direct vision of the file at the apical portion. The readings were therefore divided into three groups and statistically analysed for standard deviation and standard error.

Sample	Actual Length	Radiograph			
	CLtrue	CLconv	CLrvg	CLconv– Cltrue	CLrvg – Cltrue
1	21	20.5	21	0.5	0
2	19.5	19.5	19.5	0	0
3	20.5	20.5	21	0	0.5
4	20	21	20.5	1	0.5
5	22	22	21.5	0	-0.5
6	22.5	22.5	22	0	-0.5
7	21.5	22	21.5	0.5	0.1
8	20	20.5	20.1	0.5	0
9	19.5	20	19.5	0.5	0
10	18.5	19	18.5	0.5	0.5
11	19	19.5	19.5	0.5	0
12	19	19.5	19	0.5	0
13	20.5	20.5	20.5	0	0
14	19.5	19.5	19.5	0	0
15	21	21	20	0	1
16	20	21	20.3	1	0.3
17	20.5	21	20.5	0.5	0
18	20.5	21	20.5	0.5	0
19	21	21.5	21	0	0
20	19.5	20	19.5	0.5	0
21	19.5	20	20	0.5	0.5
22	19.5	20.5	20	1	0.5
23	20	21	20	1	0
24	20.5	20.5	20.5	0	0
25	19.5	19.5	19.5	0	0
26	18.5	19	19	0.5	0.5
27	18.5	19	18.5	0.5	0
28	20.5	21	20	0.5	0.5
29	21.5	21.5	21.5	0	0
30	20	20	20	0	0
Mean	**20.11**	**20.46**	**20.13**		
S.D				**0.5773**	**0.3605**
S.E				**0.1072**	**0.0669**

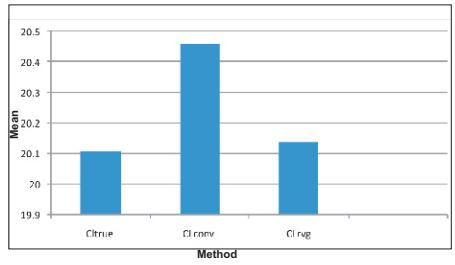

Fig.[10] Histogram Showing The Differences In average Working Length Calculated By Different Methods

From the above tables it is seen that the standard deviation and standard error of the canal length measurements of the radiovisiographs were less than those of conventional radiograph. The measurements were in the range of 0.5-1mm short of the true canal length (control) which is statistically not significant. From the histogram also it is seen that the radiographic methods overestimated the canal lengths than the readings of the radiovisiograph which were closer to the actual length.

The percentage of accuracy was also determined for both the methods. It was found that accuracyfor conventional radiograph was55.83% and for RVG 68.33%

Discussion

Accurate working length is a pre-requiste for the success of endodontic therapy. Working length establishes the apical extent of canal preparation and apical stop. Failure to accurately determine the working length may lead to increased incidence of postoperative pain or may also lead to incomplete instrumentation and under filling with attendant problems[2]. Among them should be noted, persistent pain and discomfort from inflamed shreds of retained pulpal tissues. In addition, ledge formation may develop, short of the apex, making adequate treatment or retreatment extremely difficult or impossible[3]. Finally, apical percolation may develop into the unfilled “dead space” at the apex. This could result in a prolonged healing period or continued periradicular lesion and increased incidence of failure.

Conventional root canal treatment has an overall success rate of 65-95%(Gulabivala)[10].The outcome is influenced by the quality of treatment and design and quality of the subsequent restoration.A rational approach to the treatment of disease requires an understanding of the pathological process, which in turn demands a knowledge of the normal anatomy and physiology of the tissues involved.

According to Kuttler[19] as the root tapers to the apex,the 'major diameter' of the foramen externally narrows within the canal to form the smaller 'minor diameter'which coincides with cementodentinal junction. The distance from the apical tip to the apical constriction however varies. Kuttler noted the distance to be 0.52 mm in young teeth and 0.659 mm in older teeth. Therefore, the relationship of the apex to the apical constriction should also be considered in estimating working length.

Conventional radiographs are perhaps one of the oldest means of working length determination described most acceptably by Ingle in 1957. A radiograph was taken with the file inserted in to the canal to the estimated working length 0.5-1mm short of the radioapex. Corrections were thereafter made by measuring the distance from the tip off the file to the endof the root and adding or subtracting it from the measured length[8]. Bramante et al[17]compared the methods of Best, Bregman, Ingle and Sunada and found that Ingle's method was superior to the other methods. Conventional radiographs still continue to be used for determining working length. However, some of its disadvantages include increased radiation dose, errors during film developing and time consuming procedure.

To eliminate the use of radiation electronic apexlocators were introduced by Imao Sunada[18]. He used the concept of difference in electrical resistance between pulpal and periodontal tissues to elicit an electrical response. Apex locators arereliable but not to that extent that they can replace radiographs, since the formeris sensitive to the root canal contents. They help to reduce the number of radiographs necessary if there is uncertainity about the length.

Keeping in view disadvantages of the above systems digital radiography was introduced by Mouyen et al.[16]. According to this study the Radiovisiography system considerably reduced levels of radiation to produce an image immediately after exposure. The resolution of RVG was lower than that of silver halide emulsion films but in RVG the image can be magnified and the contrast altered for the best possible view. Sullivan et al[5]. in his study of RVG in the detection of periapical lesions also concluded that RVG with variable contrast tended to detect smaller lesions better. Conventional radiographs were able to detect the lesion free state better. However, under normal conditions resolutions of RVG is significantly lower than conventional radiographs as observed by study of Ludlow et al[4].

This in vitro investigation was undertaken to compare conventional radiography to RVG for the imaging of the root canal. The result of both conventional radiograph and RVG, showed a significant greater length than the true length. Actual true canal length was determined previously by direct vision of the file at the root tip. The samples were mounted in opaque acrylic material and placed on the radiographic platform. Working length was estimated using both the conventional radiographic method and by direct digital radiography (RVG).for the direct digital method the length of the file was imaged in the computer monitor and working length calculated using as many clicks as required. The contrast was adjusted so as to obtain the best possible image.

The results were divided into three groups CLtrue for true canal length, CLconv for conventional radiograph, and CLrvg for radiovisiograph. The CLtrue served as a control to which the accuracy of both radiographic and radiovisiographic lengths were compared. Standard deviation, for both the methods were obtained and standard error was calculated. Standard deviation and standard error for RVG was smaller than for conventional radiographs.

However both were range of 0.5-1 mm short of the apex. Also the percentage of accuracy for conventional radiograph was less (55.83%) as compared to the RVG (68.33%). Thus we conclude from the study that the root canal length measurements by RVG are more accurate than those of conventional radiographs. However, the difference between the two methods were not statistically significant.

Considering the above advantages of direct digital radiography, RVG is definitely superior to conventional radiograph as far as radiation dose and chairside time are concerned. Further research with direct digital systems will be needed for it to completely replace radiographs.

Conclusion

The objective of this study was therefore

1) To determine the efficacy of the RVG in estimating working length.
2) To determine the accuracy of the RVG and conventional radiograph in determining working length by comparing it with the actual length.

The results observedshowed that the standard error of RVG (Clrvg-CLtrue) was less than the standard error of conventional radiograph (CLconv-CLtrue) both being in the range of ± 0.5 to 1 mm which is not statistically significant.

With increasing research in the field of direct digital radiography, RVG is definitely the wave of the future.New generations of digital imaging systems especially make resolution of images better than the previous ones.

References

References are available on request at editor@healtalkht.com