Radiographic Assessment of Tooth Furcation Area Measurements before and after Endodontic Treatment

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Abstract

Aim: To assess radio-graphically the height of furcal area in molar teeth before and after root canal treatment and to evaluate changes in root furcation measurements after endodontic treatment performed by dental undergraduate students of College of Dentistry. **Materials & method:** The root-furcation measurements were taken from 201 bite-wing radiographs of pre-root canal treatment and post-root canal treatment performed by dental students of College of Dentistry. The teeth that obscured the image of pulp chamber due to crowns or restorations were excluded from the study. The data; hence, obtained was put to statistical analysis. The data variables were compared by employing paired t-test and one-way ANOVA. **Results:** In the present study, the mean values of furcation height of teeth before root canal treatment (RCT) was 2.329 ± 0.5445 and it was 1.991 ± 0.6005 after undergoing RCT; the difference between the two was found to be statistically significant (p<0.001). On comparing the difference of mean height of furcation area of teeth before and after RCT with respect to maxillary and mandibular teeth; a non-significant (p=0.265) difference was found. **Conclusion:** The mean values of furcation heights of teeth before root canal treatment (RCT) was 2.329 ± 0.5445 and it was 1.991 ± 0.6005 after undergoing RCT; the difference between the two was found to be statistically significant. The changes in the furcal area measurements before and after RCT depict that the students performed over-instrumentations while undertaking the endodontic procedures among patients.

Keywords: Furcation; Radiographic assessment; Root canal treatment

Introduction

Inadvertent events defined as procedure accidents are quite possible during root canal treatment. [1] Such unforeseen and unintentional circumstances occur unfortunately due to lack of knowledge or attention or may be totally involuntary and unforeseeable. One of the most leading causes of such mishaps is iatrogenic in nature such as over-instrumentation in the pulp chamber. [2] Other sources of endodontic accidents reported in previous studies are lack of knowledge about pulpal and dental morphology and lack of radiographic information. [3]

Notwithstanding the fact that endodontic mishaps are not unusual, it is still undeniable that their occurrence impairs obligation of a dentist to be efficient enough to avoid or at least minimize such procedural accidents: one of the ways being to obtain the proper, optimal, careful and perfect interpretation of the pre-operative dental radiographs. In addition to the correct pre-operative radiographic analysis, pre-operative case-assessment and risk-evaluation hold an equally important place as well. The axiom reads: prevention is always better than repair, even under assumption of possibility of repair.

Conservation of the remaining tooth structure is one of the main objectives of access cavity preparation during root canal treatment procedure. [4,5] For a successful outcome of endodontic-treatment, knowledge regarding both the internal as well as the external anatomy of teeth and; practicing in a conservative approach are the factors of utmost importance for the dental professional. [6]

Most of root canal treatment procedures are challenging for an undergraduate dental student. They usually require competent technical skills and expertise as well as an understanding of pulp anatomy with its variations. Many studies have evaluated the performance or quality of root canal treatments performed by undergraduates either in cross-sectional studies or in retrospective studies [7-9] wherein different levels of competence towards root canal treatment procedures have been reported. In yet another study conducted previously among the undergraduate students of Britain and United States, one of the causes of unsatisfactory endodontic treatment in general practice was reported to be the lack of basic knowledge about endodontic principles and the lack of proficiency among the students. [10] Similar reports were explored in Arabic countries such as Sudan, [11] Saudi Arabia [12] and Jordan. [13] Balto et al. [14] assessed the furcal perforations by reporting the extrusion of filling material from furcation area.

In perspective of the aforementioned facts, a study was conducted to assess radio-graphically the height of furcal area in molar teeth before and after root canal treatment and to evaluate changes in root furcation measurements after endodontic treatment performed by dental undergraduate students.

Materials and Methods

A retrospective study was conducted to assess the root furcation measurements taking 201 radiographs of pre-root canal treatment and post-root canal treatment performed by dental students. Prior to the start of study, ethical approval was taken from the Scientific Research Committee, (SRC/REG/2017-2018/49). The study was conducted for a period of 6 months.

Sample size estimation:

$$n = \frac{\left(\sigma1^2 + \sigma2^2\right)\left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2}{\Delta^2}$$

The notation for the formula is:

n=Sample size of Groups

σ1=Standard deviation of Group 1=0.698

σ2=Standard deviation of Group 2=0.710

Δ=Difference in group means=0.1975

Z1-α/2 =Two-sided Z value (e.g., Z=1.96 for 95% confidence interval).

Z1-β=Power=80%

With the help of literature survey, we have found the expected standard deviation of group 1 & group 2 are 0.698, 0.7104 respectively and mean difference is 0.1975 of two groups for variables. Using the above formula with and software Open Epi, Version 3, the sample size was estimated to be 200.

Bitewing radiographs of 201 molar teeth of patients were taken under standardized conditions in the department of Restorative Dental Science, KKU. All radiographs were taken using Kodak RVG 6500 system (Atlanta, Georgia) with sensor size 1; in the same direction and angulations. The teeth that obscured the image of pulp chamber due to crowns or restorations were excluded from the study. The intra-examiner and inter-examiner reliability were assessed by a pilot study using Cronbach's Alpha and it was found to be satisfactory (91%, each).

Figure 1 shows fist line (A) was drawn from the left side CEJ to CEJ on right side. Then the second line (B) was drawn parallel to the line A and passing through the fornix. The last line (C) was drawn through the pulp chamber floor (C). The line A and B were used to take the measurement of root trunk (RT) height and the line B and C were taken to obtain the height of furcation area (G).

Data analysis

The data were analyzed with Statistical Package for Social Sciences software (SPSS version 20.0, Chicago, IL, USA). Mean values and standard deviations (SD) of data results were measured using descriptive statistics. The significance was measured based at $p < 0.05$ for all statistical tests. The data

Table 1: Comparison of mean ± S.D. of furcation area width of teeth before and after RCT.

	N	Mean ± Std. Deviation	Mean diff.	t	d.f.	p value
Pre RT	201	4.123 ± .6989	0.2000	7.982	200	<0.001*
Post RT	201	3.923 ± .6534				
Pre G	201	2.329 ± .5445	0.3388	10.415	200	<0.001*
Post G	201	1.991 ± .6005				

*Highly significant p<0.01; {Paired t-test}

Table 2: Comparison of mean ± S.D. of difference pre G & post G between maxillary and mandibular teeth.

Group	N	Mean ± Std. Deviation	Mean difference	t	d.f,	p value
Maxillary teeth	42	.4095 ± .50210	.008940	1.118	199	0.265^
Mandibular teeth	159	.3201 ± .44958				

^Non-significant; Independent t-test.

Table 3: Comparison of mean ± S.D. of difference pre RT & post RT between maxillary and mandibular teeth.

Group	N	Mean ± Std. Deviation	Mean difference	t	d.f.	p-value
Maxillary teeth	42	0.3143 ± 0.52895	0.14447	1.705	47.581	0.095^
Mandibular teeth	159	0.1698 ± 0.28767				

Independent t- test; ^Non-significant

Table 4: Inter-examiner and intra-examiner reliability.

Reliability Statistics		Intra-class Correlation	95% Confidence Interval		F Test with True Value 0				Cronbach's Alpha
			Lower Bound	Upper Bound	Value	df1	df2	p-value	
Intra observer	Single Measures	0.577	0.522	0.634	11.924	200	1400	0.000	0.916
	Average Measures	0.916	0.897	0.933	11.924	200	1400	0.000	
Inter observer	Single Measures	0.579	0.524	0.635	11.995	200	1400	0.000	0.917
	Average Measures	0.917	0.898	0.933	11.995	200	1400	0.000	

variables were compared by employing paired t-test and one way ANOVA.

Results

In the present study, the mean values of furcation height before and after root canal treatment was found to be 2.329 ± 0.5445 and 1.991 ± 0.6005, respectively. The difference of mean values of furcation height was found to be statistically significant (p<0.001). The mean values of root trunk (RT) height of teeth before RCT was 4.123 ± 0.6989 and it was 3.923 ± 0.6534 after undergoing RCT; the difference between the two was found to be statistically significant (p<0.001) [Table 1]. The mean values of furcation height of teeth before and after root canal treatment with respect to different age groups of patients is shown in Figure 2. The frequency distribution of teeth according to location is shown in Figure 3.

The mean difference of standard deviations of root furcation height of maxillary and mandibular molar teeth, pre and post RCT was found to be 0.8940 which was statistically non-significant (p=0.265) [Table 2]. On comparing the difference of mean root trunk height of teeth before and after RCT with respect to maxillary and mandibular teeth; a non-significant (p=0.095) difference was found [Table 3].

For intra-observer reliability, the Cronbach's Alpha is 0.916 and Correlation coefficient with 95%, CI is 0.577 (.522-.634); while for inter-observer reliability; the Cronbach's Alpha is 0.917 and Correlation coefficient with 95% CI is 0.579 (.524-.635) [Table 4].
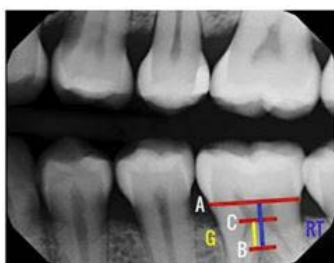

Figure 1: Shows fist line (A) was drawn from the left side CEJ to CEJ on right side. Then the second line (B) was drawn parallel to the line A and passing through the fornix. The last line (C) was drawn through the pulp chamber floor (C). The line A and B were used to take the measurement of root trunk (RT) height and the line B and C were taken to obtain the height of furcation area (G).
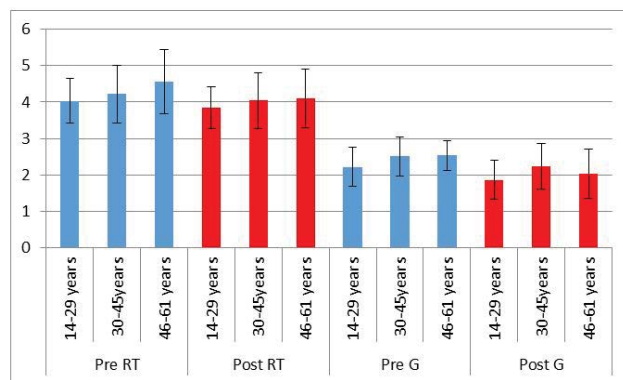

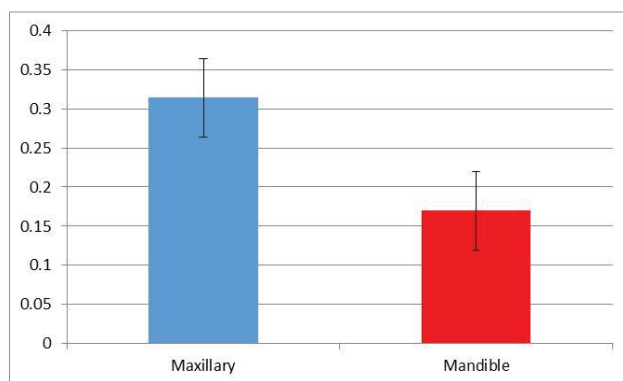**Figure 2:** Comparison of mean ± S.D. of Pre G, Post G and Pre RT, Post RT between different age groups.

Figure 3: Frequency distribution of teeth according to location (Maxillary and mandibular).

Discussion

The furcation has been defined by the Glossary of periodontal terms as "the anatomic area of a multi-rooted tooth where the roots diverge." [15] The prognosis and treatment of the tooth depends on the root trunk measurements as far as periodontal disease is concerned. [16] The accuracy of clinical furcation assessment is affected by the position of tooth, morphology and inclination of roots, root-trunk length, extent of divergence of roots and residual inter-radicular bone- configuration. [17,18] Previously various studies have been conducted on anatomical characteristics of molar teeth. [19-21]

In several studies, the morphology of furcation has been related to floor of the pulp chamber. Sterrette and Pelletier in their study reported the range of 2.7 to 3 mm as the distance of floor of the pulp chamber to the five pre-determined sites on the furcation of root surface of maxillary and mandibular teeth. [22]

Over instrumentation especially in danger zone of root-dentin during bio-mechanical preparation of endodontic treatment of tooth leads to iatrogenic-furcation involvement. [23,24] According to Kessler et al. study indings, the danger zone is located 4 to 6 mm below the orifice of the root canal chamber. [24] The tooth becomes more susceptible to fracture due to over-instrumentation in the danger zone as it has lesser tooth structure when compared to that of peripheral area of root (safe zone).

Appropriate diagnosis, treatment and good prognosis is of utmost importance for successful endodontic procedure which

is in turn decided by a quality radiographic assessment and measurements. Hence, a study was conducted to assess the changes in the furcation measurements before and after the root canal treatment of maxillary and mandibular molar teeth of patients treated by dental students.

The results of the present study showed that the mean values of furcation width of teeth before root canal treatment (RCT) was 2.329 ± 0.5445 and it was 1.991 ± 0.6005 after undergoing RCT; the difference between the two was found to be statistically significant (p<0.001). These findings depict that mishaps may occur during endodontic procedures leading to the unnecessary loss of tooth structure at furcation area of multi-rooted teeth during endodontic procedures by dental students.

The importance of preventing the iatrogenic involvement of furcation area of teeth has been emphasised in a previously conducted study wherein the researchers have mentioned that the clinicians should consider the important factors such as root-trunk length, furcation-area anatomy, presence of accessory canals, remaining dentin-thickness, post-instrumentation in danger zone and micro-cracks by endodontic rotary instruments. In addition to these factors, the pre-treatment evaluation of roots and root-canal morphology is quite essential. [25]

Furthermore, in the current study, the difference of mean width of furcation area of teeth before and after root canal treatment (RCT) with respect to maxillary and mandibular teeth; a was found to be non-significant (p=0.095); indicating that the position of teeth did not affect the furcation measurements while endodontic treatment procedure performed by the students. To conclude, the dentist must consider all the factors well before performing the endodontic procedures especially the radiographic assessment and measurements of furcation area of the multi-rooted teeth. It becomes a greatest challenge to the clinician to deal with the tooth that has furcation involvement due to pulpal, periodontal or iatrogenic factors; thereby making it quite difficult for the clinician to access this area due to it complicated structure. [20] Moreover, the tooth integrity needs to be preserved to resist forces of fracture.

Limitation

The association between the furcation width measurement and success of endodontic treatment of teeth was not assessed.

Conclusion

The mean values of furcation heights of teeth before root canal treatment (RCT) was 2.329 ± 0.5445 and it was 1.991 ± 0.6005 after undergoing RCT; the difference between the two was found to be statistically significant. The reduction in the furcal area measurements after RCT depict that the students performed over-instrumentations while undertaking the endodontic procedures among patients, hence the following recommendations may be considered.

Recommendations

- The pre-operative radiographic assessment is of utmost importance prior to the start of any root canal procedures so as to avoid the unfortunate mishaps.

- Dentists should be acquainted with a thorough knowledge of tooth morphology.

- While looking for orifices of root canals, a dentist should adopt conservative approach as much as possible so as to maintain the integrity of furcation area by avoiding over instrumentation.

- Overzealous use of long shank rotary cutting instruments should not be done to avoid possible perforations.

Conflict of Interest

The authors disclose that they have no conflicts of interest.

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