New Approach in Estimation of Dental Development
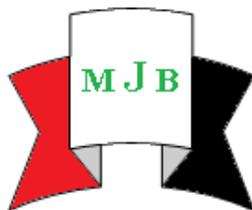
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Abstract

This study aimed to estimate the mature root length of first premolar by using the root of first molar as a reference through the panoramic radiograph.

The sample of this study included 102 panoramic radiographs of Iraqi Arab subjects with an age ranged between 17-25 years. The root length of both the first premolars and first molars are measured on good diagnostic quality panoramic radiographs by using the Planmeca Romexis Viewer software. Pearson's correlation coefficientwas used to determine the relation between the root length of first premolar and that of permanent first molar. Regression equation was used to determine the questions that predict the length of mature root of first premolars. Paired t-test was used to compare between the actual and predicted root length.

The findings showed high correlation between the root length of first premolars and that of permanent first molars. Hence, the root length of permanent first molar can be used as predictors for root length of first premolars.

Keywords: root length, prediction, panoramic radiograph.

الخلاصة

الهدف من هذه الدراسة لتخمين طول الجذر البالغ للضاحك الاول باستعمال طول جذر الضرس الاولى اكمصدر باستعمال الصورة الاشعاعية البانارومية .

تضمنت هذه الدراسة ١٠٢ عينة صورة اشعاعية بانارومية لاشخاص عراقيين بعمر تراوح بين ١٧-٢٥ سنة . ان طول جذر كل من الضواحك الاولى والاضراس الاولى قد تم دراستها على الصور الاشعاعية البانارومية ذات القيمة التشخيصية الجيدة باستعمال برامج مشاهد بلانميكا ريموكسس. معامل ارتباط بيرسون قد استعمل لتقرير العلاقة بين طول جذر الضاحك الاول مع طول جذر الضرس الاولى الدائمة.

تحليل الانحدار قد استعمل لتقرير المعادلة التي تتوقع طول الجذر البالغ لضاحك الاول . تم استخدام اختبار المقترن للمقارنة بين طول الجذر الفعلي والمتوقع .

اظهرت النتائج ارتباطا" عاليا" بين طول جذر الضواحك الاولى مع طول جذر الاضراس الاولى الدائمة . لذلك ، طول جذر الضرس الاولى الدائمة يمكن ان يستعمل لتنبؤ بطول جذر الضاحك الاول .

الكلمات المفتاحية: طول الجذر ، تنبؤ.صورة اشعاعية بانارومية.

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Introduction

During preventive & interceptive orthodontic procedures, the detection of dental development is necessary to provide the orthodontist with precious information's for proper timing [1]. For this purpose, the radiographic techniques are commonly used [2,3,4].Panoramic radiograph (OPG), which routinely taken during orthodontics, can provide a thorough examination for development of entire dentition with low radiation dose and short exposure time [5].OPG radiograph in addition to diagnostic value it can be used for accurate linear and angular measurements [6,7]. In several studies, the linear vertical measurements have been used to compare the crown and root length on panoramic radiographs of the same patient at

different times with consistent accuracy [8, 9, 10].

Serial extraction is one of most timing related interceptive procedures. It is based on root development that may be advanced or retarded relative to that expected from chronological age [11].

Several methods were considered for prediction of mature root length that a permanent tooth will be attained, subsequently; estimation of optimal timing for serial extraction. A special chart was designed for males and females to evaluate the dental maturation. The rate of root development which means the time needed for progressing throughout the quarter stages of root formation, also used to predict the time of extraction[12] .

Crown-root ratio also can be used to predict the complete root length, from the multiplication of crown length measurement by 1.6 [13].

The present investigation is carried out to find out if we can estimate the root length of 1st premolar with reference to adjacent teeth roots i.e. 1st permanent molar using OPG.

Materials and Methods

The data of this study consisted of OPGs taken at Farah Radiological Clinic in AL-Najaf city, using a digital Orthopantomograph unit (Planmeca ProOne, Helsinki, FINLAND). The patient's data was recorded, it includes name, gender, birthday, and date of radiograph taking.

The criteria's for excluding OPGs in the present study were:

1. History of orthodontic treatment.
2. Reference points not obviously visible in several teeth. (Root development is not complete, extensive caries or restorations, crowding, Missing teeth especially the 1st premolars and 1st permanent molars).
3. Radiograph not technically of good diagnostic quality (major overlapping of teeth, diffuse image, or distortion).
4. Teeth with abnormal root shape, or with any pathology.

After exclusion, the study material consisted of 102 OPGs of 71 females and 31 males, aged 17-25 years. Of these OPGs, 816 teeth roots, of 1st premolars (PM1) and permanent 1st molars (M1), were measured.

The Planmeca Romexis Viewer software installed on the X-ray unit system computer. This software enables to display the radiograph with high quality. Each OPG was viewed through this software, then drawing and measurement was done.

Long axis of each tooth was determined. For muti-rooted teeth, long axis can be done by drawing lines passing from centre of the greatest mesiodistal crown width to root bifurcation or trifurcation [14]. For single rooted teeth, the root canal image in its greatest length was selected [15].

m point which is the midpoint of a straight line connecting the mesial with distal cemento-enamel junctions. The apical reference line is drawn line forming a tangent to apex of root placed perpendicular to the long axis of the tooth. For multi-rooted teeth, the palatal root is omitted and the length is measured to the apex of longest buccal root. The root length represents the distance from point m perpendicular to the apical reference tangent [16] .
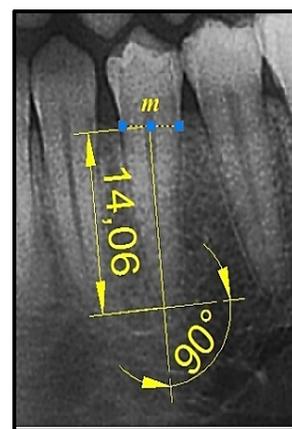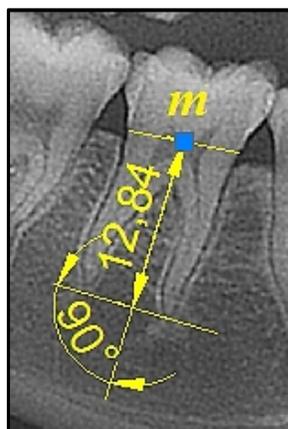
Error assessment

The error of the method was verified by the random selection of 15 panoramic x-rays that were measured twice by the same operator at different times under the same working conditions. With this repetition, the error was determined by the Student's (paired) "t" test. There was no significant difference between the two readings.

Statistical Analyses

The data were subjected to computerized statistical analyses using SPSS program (version 19). The statistical analyses included:

1. Descriptive statistics (means and standard deviations of root length of PM1 and M1).
2. Inferential statistics that comprised:
- Pearson's correlation coefficient (r) to find out the relation between the root length of M1 with that of PM1.

- Independent sample t-test to test the presence of gender difference for the measurements.
- Simple regression analysis to determine the regression equations that can be used to predict the root length of PM1.
- Paired sample t-test to show whether there is significant difference between the predicted and actual root length of PM1 in both genders.

Results:

Statistical non-significant differences were found between the two sides (in both genders) by applying student t-test. For this reason, the data of the right & left sides were pooled together in assessing the variables (Table 1 & 2).

Table 1: Descriptive statistics and side difference of the root lengths of maxillary and mandibular PM1 and M1 in male group.

Teeth	Right		Left		Side difference (d.f.=30)	
	Mean	S.D.	Mean	S.D.	t-test	p-value
Maxillary 1st premolar	13.90	0.92	14	0.82	-1.46	0.154 (NS)
Maxillary 1st molar	13.09	1.02	13.18	1.04	-1.12	0.274 (NS)
Mandibular 1st premolar	13.97	0.99	13.80	0.79	1.35	0.186 (NS)
Mandibular 1st molar	15.01	1.12	14.90	0.96	1.53	0.137 (NS)

Table 2: Descriptive statistics and side difference of the root lengths of maxillary and mandibular PM1 and M1 in female group.

Teeth	Right		Left		Side difference (d.f.=70)	
	Mean	S.D.	Mean	S.D.	t-test	p-value
Maxillary 1st premolar	13.39	1.04	13.49	1.08	-1.44	0.156 (NS)
Maxillary 1st molar	12.39	1.02	12.40	1.03	-0.19	0.846 (NS)
Mandibular 1st premolar	13.93	1	13.85	1.05	1.83	0.072 (NS)
Mandibular 1st molar	14.41	1.01	14.38	1	0.73	0.466 (NS)

A statistical analysis was carried out for both males & females to compare between the mean values of root length of (PM1) & (M1).

By comparing the mean values of root length of the entire male sample to those of the entire female sample, the result indicated that the mean values for root

length of maxillary PM1&M1with mandibular M1 were greater in males than in females at a high significant level (P ≤ 0.001). While there was no significant

difference between males and females in root length of the mandibular PM1 (P= 0.973) (Table 3).

Table 3: Descriptive statistics and gender difference of the root lengths of maxillary and mandibular PM1 and M1.

Teeth	Male (N=62)		Female (N=142)		Genders difference (d.f.=202)	
	Mean	S.D.	Mean	S.D.	t-test	p-value
Maxillary 1st premolar	13.95	0.86	13.44	1.05	3.35	0.001 (HS)
Maxillary 1st molar	13.14	1.02	12.40	1.02	4.77	0.000 (HS)
Mandibular 1st premolar	13.88	0.89	13.88	1.03	-0.3	0.973 (NS)
Mandibular 1st molar	14.95	1.04	14.40	1.00	3.62	0.000 (HS)

As shown in (Table 4), there was a direct highly significant correlation (p ≤ 0.001) between the measured variables. The correlation coefficient value showed a moderate degree of association between the roots length of PM1 and M1 in both genders and in jaws.

A linear regression analysis was performed to develop the regression equations. The equation was calculated as; Y= a + b X where "Y" is the root length of mandibular or maxillary PM1, "X" is the root length of maxillary or mandibular M1, "a" is constant and "b" is the regression coefficient. The results showed the equations as in (Table 5)

Table 4. The relation between the root length of PM1 to that of M1, in maxilla and mandible, in both genders.

M1		PM1	
		Maxillary	
		Males	Females
	r	0.52	0.57
	p	0.000(HS)	0.000(HS)

(HS)=Highly significant P ≤0.001

Table 5: Prediction the root length of maxillary and mandibular PM1 from maxillary and mandibular M1.

Genders	Maxilla	Mandible
Male	Root length of PM1= 7.952 + 0.456 (root length of M1)	Root length of PM1= 4.958 + 0.597 (root length of M1)
Female	Root length of PM1= 6.133 + 0.589 (root length of M1)	Root length of PM1= 5.154 + 0.607 (root length of M1)

After calculation the predicted root length, pairedsample t-test was applied to compare between theactual and predicted measurements. The results showed that

there was non-significant difference between the predicted and actual root length of both maxillary and mandibular PM1 (Table 6).

Table 6: The comparison betweenthe actual and predicted root length of maxillary and mandibular PM1 in both genders.

Arch	Gender	Actual root length		Predicted root length		Difference		
		Mean	S.D.	Mean	S.D.	t-test	d.f.	p-value
Maxillary	Male	13.95	0.86	13.94	0.47	0.054	61	0.957 (NS)
	Female	13.44	1.05	13.43	0.60	0.061	141	0.951 (NS)
Mandibular	Male	13.88	0.89	13.89	0.62	-0.034	61	0.973 (NS)
	Female	13.88	1.03	13.89	0.61	-0.064	141	0.949 (NS)

Discussion

In serial extraction, many studies recommended that the root length of the premolars have an important consideration at the time of removal of primary 1st molars. The sequential program of serial extraction involves extraction of 1st primary molars, which should be done when there is one-half to two-third root formation of the first premolar, usually will speed up the premolar eruption to enter the oral cavity before the permanent canines especially in the mandible [17]. Other studies showed that if the primary molars were extracted before one-half of the mature premolars root is formed, the emergence would be delayed [18, 19]. Therefore, the prediction of final root length is needed to be compared with the intermediate stages to determine the degree of root development.

This study was in accordance with other investigator showed that theroot lengthshas non-significant side difference [20]. While, the gender dimorphismin root length was indeed found [21, 22].

The roots and alveolar outlines of adjacent teeth could be used as a reference to estimate the mature root length without having a serial radiographs [12]. The roots length of human dentition show a high degree of dimensional intercorrelation [24, 25]. In accordance with those studies, the finding of this study showed that there is a high degree of association between the roots length of PM1 & M1 in both genders and in both jaws.

The root of M1 completes its development early at 9-10 years [26, 27, 28]. The time of extraction of 1st primary molars during serial extraction procedure, usually occurs at 6-12 months before the time of normal shedding [29]. On other hands, in the average development pattern the 1st deciduous molars are removed between the age 9-10 years [30]. Accordingly, it is suitable to use the M1 root, which matures early as a reference to estimate the stage of developing root of PM1.

In this study, a regression equation is designed to predict the mature length of PM1 root in both jaws, and genders, from that of M1. The findings revealed a non-significant difference between the predicted and actual root length of PM1.

Hence by using only OPG radiograph, and by measuring the root length of M1, the degree of root development of PM1can be assessed if reach its half or not, in both jaws with high reliability. Consequently determine the appropriate time of extraction of 1st primary molars.

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