A Roentgenographic Study on the Development of Human Permanent Posterior Teeth

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CONTENTS

Ⅰ. INTRODUCTION

In forensic odontologic studies, teeth have been used as basis for age estimation.

These studies have noted the biological characteristics of teeth and have discussed the significant relationship between age and changes in teeth.[1-9]

Information about age, as gleaned from teeth, may depend on many factors with the result that investigations have been carried out by a number of methods.[1-4,10-13]

In general, teeth rarely receive direct external influences during the unerupted period. However, after eruption, they show various changes not only as a result of physical causes but also from masticatory movements and other exterior causes.[3]

That is, there appear slow changes in the form of crown, root, pulp cavity, histological changes in the pulp and physio-chemical changes of hard tissue as age advances.

These various changes include attrition, secondary dentin formation, periodontal change, cementum apposition, transparency and root resorption.[4] These tooth changes have been used as basis for age estimation. All these basis were only taken from extracted teeth.

However, it is not appropriate in human, especially in childhood and adolescent who have developing teeth.

Therefore, in case of age estimation in child and adolescent who have developing teeth, the formation of tooth and emergence have been used as basis.[13]Tooth formation is superior to tooth emergence for assessing dental maturation, because the majority of the teeth can be studied at each examination.

The author, as a standard for age estimation, took selection of the stage of tooth formation.

Radiographic method is one of the most useful

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method to evaluate the stage of tooth formation.

There are a little problems in radiographic method because of radiograph is only a photograph from tooth.

It is difficult to take satisfactorily on a radiograph everything pertaining to the root orifice, pulp cavity and hard tissue of the teeth.

The distinct anatomical landmarks of tooth should be used as indicator.

The author selected mesial cusp tip, cemento-enamel junction, and mesial root as measurable indicator and sought the length of vertical right of crown and root.

Further, the author plotted out a crown-root ratio and studied the correlation with age.

The purpose of present study is to provide norms for age estimation.

Ⅱ. MATERIALS AND METHODS

1. Subjects

3,464 teeth of 722 individuals were selected and devided into 2 groups. First group consisted of 988 teeth of 189 individuals whose ages range from 20 years to 30 years were selected to analyze the crown-root ratio of fully developed teeth. Second group consisted of 2,476 teeth of 533 individuals whose ages range from 3years to 18 years were selected to analyze the crown-root ratio of developing teeth.

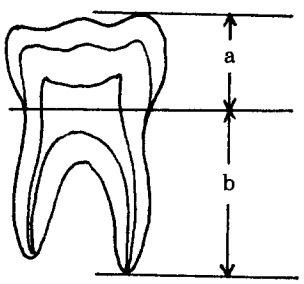
Subjects were selected according to the following criteria : (1) no evidence of distinct malocclusion (2) no history of operative and prosthethic treatment (3) no existence of any other pathologic condition influencing the tooth development (4) distinct cemento-enamel junction and tooth contour in radiograph.

2. Method

Orthopantomographs were taken at each individuals and traced as illustrated in figure Ⅰ. The evaluated teeth were confined to upper and lower first and second molars and first and second premolars. The length of crown(a) was from buccal cusp tip to cemento-enamel junction and the length of root(b) was from cemento-enamel junction to root apex. In cases of molars, mesial cusp tip and mesial root apex were chosen.

After tracing, the length of crown and root were measured with digimatic caliper (Mitutoyo, Tokyo, Japan) and the crown root ratios of each teeth were calculated with following formula.

$$\text{Crown root ratio}=\frac{\text{length of root(b)}}{\text{length of crown(a)}}$$



3. Statistical analysis

Data of each variable were inputed into an IBM personal computer and mean values and standard deviations of variables were attained using SPSS PC+(Microsoft. Corp). Statistic analysis were performed with student t-test and regression analysis.

Ⅲ. RESULTS

The mean values and standard deviations of first and second molars, first and second premolars of first group whose ages range from 20 years to 30 years were illustrated in Table Ⅰ. There were no sexual differences in crown-root ratio of each teeth($p>0.01$).

The mean values and standard deviations of first and second molars, first and second premolars of second group whose ages range from 3 years to 18years were illustrated in Table Ⅱ and Table Ⅲ.

There were no statistical differences between left and right side in crown-root ratio of each teeth($p>0.01$).

The linear equations of each teeth of second group were illustrated in Tabe Ⅳ and Table Ⅴ. The decision coefficients(r) of lower teeth were higher than that of upper teeth. And the linear equations of each teeth were highly significant ($p<0.001$), and significant at left upper first premolars in male and left upper second premolars and first molars in females($p<0.05$).

But there was no statistical significancy at right upper second premolar in females($p>0.05$).

Table Ⅰ. The mean values and standard deviations of first and second molars, first and second premolars of first groups(age range : 20−30 years)

	Males			Females			Males vs. Females	Total	
	No.	Mean	S.D	No.	Mean	S.D	2-tail probability	Mean	S.D
LRM2	59	1.673	0.268	47	1.700	0.266	0.603	1.685	0.266
LRM1	44	1.885	0.175	19	1.979	0.161	0.050	1.913	0.175
LRP2	26	2.065	0.247	26	2.259	0.256	0.011	2.162	0.267
LRP1	17	2.008	0.227	16	2.023	0.186	0.832	2.015	0.205
LLM2	71	1.175	0.250	52	1.737	0.236	0.631	1.724	0.243
LLM1	64	1.940	0.257	45	1.954	0.228	0.774	1.946	0.245
LLP2	53	2.235	0.347	44	2.241	0.304	0.936	2.238	0.327
LLP1	40	2.103	0.264	35	2.092	0.224	0.847	2.098	0.245
ULM2	38	1.598	0.331	38	1.691	0.232	0.185	1.650	0.267
ULM1	22	1.598	0.331	26	1.670	0.207	0.364	1.637	0.270
ULP2	11	1.923	0.307	12	1.943	0.264	0.870	1.933	0.279
ULP1	3	1.847	0.625	3	1.927	0.648	0.885	1.887	0.571
URM2	44	1.613	0.246	46	1.648	0.278	0.529	1.631	0.262
URM1	26	1.639	0.236	22	1.613	0.224	0.701	1.627	0.228
URP2	16	1.924	0.266	17	1.749	0.181	0.034	1.834	0.240
URP1	3	2.060	0.324	3	1.693	0.181	0.162	1.877	0.309

$p>0.01$

LRM2 : lower right 2nd molar
LRM1 : lower right 1st molar
LRP2 : lower right 2nd premolar
LRP1 : lower right 1st premolar
LLM2 : lower left 2nd molar
LLM1 : lower left 1st molar
LLP2 : lower left 2nd premolar
LLP1 : lower left 1st premolar

LRM2 : upper right 2nd molar
UPM1 : upper right 1st molar
URP2 : upper right 2nd premolar
URP1 : upper right 1st premolar
ULM2 : upper left 2nd molar
ULM1 : upper left 1st molar
ULP2 : upper left 2nd premolar
ULP1 : upper left 1st premolar

Table Ⅱ. The mean values and standard deviations of first and second molars, first and second premolars of males in second group(age range : 3−18years).

	3	4	5	6	7	8	9
	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)
LRM2					0.188±0.127(4)	0.187±0.063(6)	0.391±0.243(8)
					(0.151)	(0.757)	(0.106)
LRM1	0.143±0.025(3)	0.238±0.146(11)	0.540±0.195(17)	0.760±0.284(18)	1.375±0.271(15)	1.458±0.175(15)	1.508±0.211(10)
		(0685)	(0.544)	(0.707)	(0.309)	(0.963)	(0.351)
LRP2				0.020±0.000(1)	0.176±0.105(9)	0.258±0.182(18)	0.397±0.200(15)
					(0.567)	(0.827)	(0.724)
LRP1				0.210±0.101(3)	0.266±0.161(8)	0.363±0.195(16)	0.522±0.273(16)
				(0.574)	(0.711)	(0.221)	(0.839)
LLM2					0.233±0.117(3)	0.140±0.055(8)	0.496±0.489(11)
					(0.216)	(0.077)	(0.353)
LLM1	0.288±0.225(6)	0.323±0.222(12)	0.567±0.193(21)	0.884±0.287(26)	1.360±0.2561(19)	1.475±0.156(23)	1.586±0.213(22)
	(0.574)	(0.681)	(0.053)	(0.681)	(0.695)	(0.817)	(0.563)
LLP2				0.123±0.025(3)	0.208±0.091(12)	0.277±0.137(21)	0.427±0.228(16)
				(0.349)	(0.382)	(0.389)	(0.589)
LLP1				0.230±0.064(6)	0.252±0.120(13)	0.355±0.121(20)	0.604±0.461(8)
				(0.662)	(0.688)	(0.314)	(0.848)
ULM2					0.350±0.000(1)	0.320±0.000(1)	0.445±0.179(4)
							(0.339)
ULM1		0.150±0.000(1)		0.568±0.283(6)	1.142±0.334(12)	1.212±0.239(10)	1.468±0.216)(13)
						(0.845)	(0.041)
ULP2					0.300±0.000(1)		0.450±0.282(4)
ULP1					0.260±0.000(1)	0.390±0.156(2)	0.667±0.313(3)
URM2					0.227±0.065(3)	0.260±0.107(4)	0.468±0.172(5)
					(0.613)	(0.594)	(0.953)
URM1	0.080±0.000(1)	0.305±0.007(2)	0.427±0.169(3)	0.946±0.475(7)	1.164±0.269(15)	1.352±0.157(18)	1.430±0.170(15)
					(0.796)	(0.028)	(0.338)
URP2					0.380±0.072(3)	0.505±0.346(2)	0.561±0.276(7)
URP1					0.450±0.000(1)	0.347±0.186(3)	0.580±0.396(2)

10	11	12	13	14	15	16	17	18
Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)	Mean±S.D.(No) (Probability)
0.547±0.291(6)	0.758±0.309(18)	0.1053±0.435(12)	1.151±0.1941(8)	1.423±0.107(6)	1.514±0.329(13)	1.670±0.053(3)	1.713±0.155(6)	1.352±0.194(5)
(0.994)	(0.955)	(0.989)	(0.127)	(0.792)	(0.445)	(0.513)	(0.024)	(0.097)
1.723±0.126(6)	1.688±0.205(11)	1.889±0.152(8)	1.756±0.161(5)	1.920±0.303(3)	1.854±0.248(5)	1.720±0.000(1)	1.735±0.117(4)	1.750±0.017(3)
(0.141)	(0.905)	(0.226)	(0.223)	(0.161)	(0.686)		(0.794)	
0.703±0.269(8)	0.983±0.410(19)	1.398±0.479(12)	1.323±0.404(2)	2.025±0.219(2)	1.931±0.495(9)	2.000±0.184(2)	1.985±0.177(2)	1.975±0.180(6)
(0.509)	(0.554)	(0.544)	(0.032)	(0.336)	(0.874)	(0.765)	(0.783)	
0.857±0.264(7)	1.148±0.500(15)	1.350±0.440(6)	1.437±0.557(6)	1.990±0.000(1)	1.895±0.140(4)	1.770±0.000(1)	1.885±0.007(2)	
(0.809)	(0.577)		(0.400)		(0.226)			
0.495±0.251(8)	0.852±0.353(19)	1.072±0.430(13)	1.166±0.293(9)	1.538±0.208(5)	1.497±0.284*13)	1.738±0.147(6)	1.570±0.205(5)	1.552±0.332(5)
(0.339)	(0.600)	(0.966)	(0.047)	(0.698)	(0.832)	(0.236)	(0.966)	(0.980)
1.811±0.214(7)	1.740±0.262(24)	1.764±0.196(14)	1.754±0.157(8)	1.703±0.213(6)	2.004±0.267(8)	1.860±0.141(6)	1.843±0.1861(5)	1.743±0.094(6)
(0.937)	(0.911)	(0.811)	(0.910)	(0.817)	(0.077)	(0.252)	(0.204)	(0.088)
0.686±0.269(9)	1.017±0.451(24)	1.567±0.428(17)	1.346±0.497(8)	2.066±0.157(5)	2.115±0.310(11)	2.047±0.186*7)	2.088±0.275(8)	1.928±0.125(6)
(0.144)	(0.516)	(0.197)	(0.005)	(0.028)	(0.081)	(0.159)	(0.552)	(0.286)
0.741±0.215(8)	1.166±0.401(23)	1.436±0.364(16)	1.423±0.453(9)	1.724±0.080(5)	1.800±0.258(8)	1.833±0.208(4)	1.780±0.071*4)	1.770±0.094(4)
(0.124)	(0.591)	(0.982)	(0.018)	(0.551)	(0.734)	(0930)	(0.704)	(0.823)
0.447±0.215(3)	0.677±0.179(6)	0.990±0.503(7)	1.380±0.159(5)	1.307±0.067(3)	1.490±0.298(6)		1.467±0.255(3)	1.525±0.021(2)
(0.623)	(0.972)	(0.961)	(0.879)	(0.779)	(0.814)		(0.591)	
1.650±0.177(5)	1.482±0.265(13)	1.538±0.114(5)	1.687±0.176(3)	1.653±0.271(3)	1.415±0.247(2)		2.710±0.000(1)	
	(0.442)	(0.227)	(0.314)	(0.223)				
0.897±0.610(3)	1.054±0.523(5)	1.575±0.629(2)	1.470±0.000(1)	1.860±0.000(1)		1.560±0.000(1)	1.870±0.000(1)	
	(0.691)							
0.820±0.000(1)	0.810±0.000(1)							
0.310±0.000(1)	0.836±0.388(10)	1.129±0.419(13)	1.093±0.225(4)	1.380±0.113(2)	1.456±0.221(5)		1.495±0.262(2)	1.550±0.000(1)
	(0.306)	(0.705)	(0.851)	(0.986)	(0.913)		(0.868)	
1.525±0.205(2)	1.518±0.336(12)	1.550±0.192(8)	1.460±0.269(2)		1.910±0.312(3)		1.590±0.000(1)	1.870±0.000(1)
(0.704)	(0.429)	(0.418)			(0.169)			
0.942±0.528(5)	1.000±0.198(7)	1.513±0.371(6)	1.495±0.375(2)	2.90±0.000(1)	1.910±0.000(1)		1.653±0.160(3)	1.610±0.071(2)
	(0.828)		(0.990)					
0.742±0.429(3)	0.977±0.239(6)				1.770±0.000(1)		1.760±0.113(2)	1.710±0.000(1)

Table Ⅲ. The mean values and standard deviations of first and second molars, first and second premolars of females in second group(age range : 3−18 years).

	3	4	5	6	7	8	9
	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)
LRM2				0.140±0.000(1)	0.101±0.058(7)	0.199±0.086(13)	0.255±0.127(13)
LRM1	0.320±0.000(1)	0.261±0.123(13)	0.598±0.318(13)	0.803±0.362(15)	1.261±0.179(8)	1.463±0.283(8)	1.590±0.180(8)
LRP2			0.150±0.000(1)	0.205±0.000(1)	0.151±0.055(11)	0.272±0.055(8)	0.433±0.301(10)
LRP1			0.060±0.000(1)	0.172±0.111(8)	0.240±0.111(8)	0.258±0.068(6)	0.499±0.179(7)
LLM2				0.480±0.580(2)	0.135±0.069(4)	0.208±0.091(8)	0.353±0.175(12)
LLM1	0.395±0.191(2)	0.362±0.265(16)	0.762±0.387(15)	0.923±0.357(19)	1.324±0.216(11)	1.460±0.251(16)	1.631±0.198(11)
LLP2			0.120±0.000(2)	0.173±0.078(3)	0.170±0.093(8)	0.320±0.165(16)	0.474±0.252(15)
LLP1		0.250±0.000(1)	0.145±0.078(2)	0.268±0.195(8)	0.270±0.086(11)	0.407±0.174(13)	0.638±0.451(11)
ULM2					0.180±0.000(1)	0.217±0.087(7)	0.330±0.052(3)
ULM1			0.750±0.000(1)		1.350±0.000(1)	1.240±0.230(4)	1.218±0.068(4)
ULP2					0.120±0.000(1)		
ULP1					0.270±0.000(1)		
URM2					0.185±0.106(2)	0.222±0.097(5)	0.461±0.206(8)
URM1			1.000±0.000(1)	0.420±0.000(1)	1.110±0.311(2)	1.193±0.136(7)	1.310±0.305(3)
URP2					0.420±0.000(1)		
URP1						0.420±0.000(1)	

10	11	12	13	14	15	16	17	18
Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)	Mean±S.D.(No)
0.546±0.345(11)	0.764±0.255(14)	1.056±0.236(9)	1.313±0.217(9)	1.401±0.818(9)	1.631±0.305(7)	1.540±0.325(2)	1.470±0.137(5)	1.647±0.225(3)
1.568±0.192(5)	1.677±0.143(6)	1.770±0.147(4)	1.528±0.370(8)	1.657±0.206(6)	1.806±0.194(10)	1.775±0.262(2)	1.755±0.089(4)	1.540±0.000(1)
0.845±0.553(12)	0.898±0.291(11)	1.518±0.313(8)	1.787±0.455(12)	1.780±0.313(8)	1.901±0.307(10)	1.945±0.134(2)	2.023±0.117(3)	2.257±0.263(3)
0.808±0.439(6)	1.353±0.294(3)		1.679±0.440(7)	1.915±0.092(2)	1.713±0.212(3)	2.000±0.000(1)	1.680±0.000(1)	
0.623±0.319(15)	0.790±0.314(15)	1.079±0.258(10)	1.390±0.192(12)	1.582±0.204(11)	1.521±0.293(10)	1.515±0.389(2)	1.575±0.109(4)	1.558±0.282(4)
1.799±0.396(14)	1.732±0.143(13)	1.747±0.157(13)	1.762±0.170(14)	1.737±0.287(7)	1.791±0.236(12)	1.753±0.124(4)	1.715±0.075(4)	1.600±0.014(2)
0.937±0.450(15)	1.102±0.342(17)	1.351±0.481(14)	1.852±0.331(18)	1.817±0.188(9)	1.922±0.216(14)	1.860±0.135(3)	1.977±0.225(3)	2.074±0.286(5)
1.001±0.412(11)	1.238±0.338(13)	1.433±0.422(11)	1.809±0.175(11)	1.807±0.290(7)	1.847±0.318(11)	1.843±0.061(4)	1.830±0.255(2)	1.810±0.332(3)
0.526±0.227(7)	0.682±0.306(5)	1.007±0.381(3)	1.408±0.350(4)	1.220±0.492(4)	1.435±0.078(2)		1.605±0.247(2)	1.300±0.000(1)
1.640±0.000(1)	1.325±0.219(2)	1.378±0.248(5)	1.496±0.263(5)	1.325±0.134(2)	1.650±0.000(1)		1.580±0.000(1)	1.380±0.113(2)
1.850±0.000(1)	1.220±0.099(2)		1.628±0.238(5)	1.617±0.172(3)	1.420±0.141(2)			
	1.250±0.000(1)							
0.478±0.219(10)	0.677±0.244(9)	1.227±0.226(3)	1.133±0.375(6)	1.374±0.434(5)	1.473±0.179(3)		1.530±0.014(2)	1.395±0.176(4)
1.450±0.227(5)	1.375±0.134(4)	1.472±0.141(6)	1.493±0.123(4)	1.775±0.021(2)	1.460±0.438(2)			
1.750±0.000(1)	1.060±0.735(2)		1.493±0.123(4)	1.775±0.021(4)	1.460±0.438(2)			
				1.850±0.000(1)				

Table Ⅳ. The linear equations of each teeth of males in second group(age range : 3−18years)

	a	b	r	r^2	sig.F
LRM2	4.599	7.832	0.8337	0.6950	***
LRM1	5.179	2.324	0.7948	0.6317	***
LRP2	3.863	7.432	0.8638	0.7461	***
LRP1	3.472	7.120	0.8352	0.6976	***
LLM2	4.447	7.938	0.8045	0.6473	***
LLM1	5.954	1.495	0.7777	0.6047	***
LLP2	3.894	7.253	0.8689	0.7550	***
LLP1	4.189	6.717	0.8370	0.7006	***
URM2	4.430	7.722	0.7538	0.5683	***
URM1	4.645	2.886	0.6894	0.4753	***
URP2	4.391	6.686	0.7700	0.5928	***
URP1	5.564	6.037	0.9032	0.8153	***
ULM2	4.587	7.966	0.7882	0.6212	***
ULM1	4.047	4.124	0.6352	0.4035	***
ULP2	2.920	8.089	0.7277	0.5296	***
ULP1	3.264	6.970	0.7292	0.5173	*

Y=ax+b(Y : estimated age, X=crown-root ratio)

*** : p<0.001
** : p<0.01
* : p<0.05

Table Ⅴ. The linear equation of each teeth of females in second group(age range : 3−18years)

	a	b	r	r^2	sig.F
LRM2	4.857	7.429	0.8975	0.8054	***
LRM1	5.919	2.018	0.8144	0.6633	***
LRP2	3.675	7.275	0.8819	0.7777	***
LRP1	4.001	6.544	0.9024	0.8143	***
LLM2	4.653	7.365	0.8598	0.7393	***
LLM1	5.449	2.012	0.7553	0.5704	***
LLP2	3.772	7.025	0.8719	0.7601	***
LLP1	4.327	6.193	0.8524	0.7266	***
URM2	4.876	7.606	0.8311	0.6908	****
URM1	6.754	1.891	0.5378	0.2893	***
URP2	1.245	10.578	0.1908	0.0364	
URP1	–	–	–	–	
ULM2	4.454	7.803	0.8443	0.7128	***
ULM1	6.336	2.911	0.4688	0.2198	*
ULP2	3.105	8.082	0.6381	0.4072	*
ULP1	–	–	–	–	

Y=aX+b(Y : estimated age, X=crown-root ratio)

*** : p<0.001
** : p<0.01
* : p<0.05

Ⅳ. DISCUSSION

It is possible for the dentist to estimate the approximate age of an individual by a study of the age of the tooth.

Anatomical, radiological, and even microscopical examinations can be of value.

A great number of tooth changes take place, nearly all of which have been utilized.

Such changes are abrasion, some types of defects, changes in the supporting tissues, and changes in the pulp.[4]

In addition, chemical changes in enamel and dentin have been related to the chronological age.

The number of teeth and their state varies considerably, all methods only permit estimations to be carried out when the teeth are relatively intact, so that badly carious or otherwise destroyed teeth are generally of little value.

The teeth may be examined in situ in the jaw or following extraction, either singly or together with other teeth from the same individual.

It is, of course, essential that an optimal radiographic technique be used to reproducible images of the teeth with minimal distortion.[13]

Foreshortened or elongated projections of a developing tooth affect the reliability of assessment. It may be emphasized that radiography of teeth prior to emergence, especially in childhood and adolescent.[10]

The availability of a series rather than a single isolated film adds considerably in refining the precision of judgement.[7,12,14]

From these viewpoints, the author have used orthopantomograph in the present study.

In the present study, there was no sexual differences in crown-root ratio of each teeth(Table Ⅰ). These results were not in agreement with past investigators.[10,17,18]

It was suggested that more subjects should be included to improve the accuracy of research.

In the present study, there was no differences between left and right side in crown-root ratio of each teeth(Table Ⅱ, Ⅲ). These results were in agreement with past investigators.[13-17]

The linear equation of each teeth were significant, except upper right second premolars in females (Table Ⅳ, Ⅴ).

The decision coefficients of lower teeth were higher than that of upper teeth.

Assessment on radiograph of maxillary teeth is more difficult than that of mandibular teeth.

For the assessment of age during the period of development, tables are available which show diagrammatically the commencement of mineraliz ation, the completion of the crown, the eruption and completion of the root.

It is evident, however, that all types of tables including those presented here must be used with care, and then only by persons who are well aware of the variations in the biological events with which we are dealing.[4]

Although the methodology of the present study is a little different from past research, the author, as one standard of age estimation on the basis of teeth, proposes the effectiveness of the present method using crown-root ratio on radiograph.

Ⅴ. CONCLUSION

The author evaluated the development of upper and lower molars and premolars in order to make basic data that are necessary to estimate the age. 3,464 teeth of 722 individuals who took the orthopantomograph were selected to analyze the development of teeth by means of crown-root ratio.

The obtained results were as follows :

1. There were no sexual differences in crown-root ratio of fully developed teeth($p>0.01$).
2. There were no statistical differences in crown-root ratio between left and right side of developing teeth($p>0.01$).
3. For the purpose of age estimation according to crown root ratio of each teeth, linear equa-

tions are as follows :

Males

lower left

2nd molar : Y=4.599X+7.832 (r=0.8337)
1st molar : Y=5.179X+2.324 (r=0.7948)
2nd premolar : Y=3.863X+7.432 (r=0.8638)
1st premolar : Y=3.472X+7.120 (r=0.8352)

right

2nd molar : Y=4.447X+7.938 (r=0.8045)
1st molar : Y=5.954X+1.495 (r=0.7777)
2nd premolar : Y=3.894X+7.253 (r=0.8689)
1st premolar : Y=4.189X+6.717 (r=0.8370)

upper left

2nd molar : Y=4.430X+7.722 ((r=0.7538)
1st molar : Y=4.645X+2.886 (r=0.6894)
2nd premolar : Y=4.391X+6.686 (r=0.7700)
1st premolar : Y=5.564X+6.037 (r=0.9032)

right

2nd molar : Y=4.587X+7.966 (r=0.7882)
1st molar : Y=4.047X+4.124 (r=0.6352)
2nd premolar : Y=2.920X+8.089 (r=0.7277)
1st premolar : Y=3.264X+6.970 (r=0.7292)

Females

lower left

2nd molar : Y=4.857X+7.429 (r=0.8975)
1st molar : Y=5.919X+2.018 (r=0.8144)
2nd premolar : Y=3.675X+7.275 (r=0.8819)
1st premolar : Y=4.001X+6.544 (r=0.9024)

right

2nd molar : Y=4.653X+7.365 (r=0.8598)
1st molar : Y=5.449X+2.012 (r=0.7553)
2nd premolar : Y=3.772X+7.025 (r=0.8719)
1st premolar : Y=4.327X+6.193 (r=0.8524)

upper left

2nd molar : Y=4.876X+7.606 (r=0.8311)
1st molar : Y=6.754X+1.891 (r=0.5378)
2nd premolar : Y=1.245X+10.578 (r=0.1908)
1st premolar : –

right

2nd molar : Y=4.454X+7.803 (r=0.8443)
1st molar : Y=6.336X+2.911 (r=0.4688)
2nd premolar : Y=3.105X+8.082 (r=0.6381)
1st premolar : –

4. The crown-root ratio of lower teeth in orthopantomograph could be used more accurately than that of upper teeth to estimate the age.

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영구 구치 발육에 관한 방사선학적 연구

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[국문초록]

저자는 연령을 추정하기 위한 기본자료를 얻기 위하여 상하악의 대구치, 소구치의 발육정도를 평가하였다. Orthopantomograph를 촬영한 722명의 3,464개 치아를 대상으로 crown-root ratio를 측정하여 발육정도를 평가하였으며, 다음과 같은 결론을 얻었다.

1. 완전히 형성된 치아의 crown-root ratio에는 남녀간에 유의한 차이가 없었다.
2. 발육중인 치아의 crown-root ratio에는 좌우측간에 유의한 차이가 없었다.
3. 각 치아의 crown-root ratio를 이용한 연령추정의 회귀방정식은 다음과 같다.

남자 :		여자 :	
하악 좌측	제2대구치 : Y=4.599X+7.832(r=0.8337)	하악 좌측	제2대구치 : Y=4.857X+7.429(r=0.8975)
	제1대구치 : Y=5.179X+2.324(r=0.7948)		제1대구치 : Y=5.919X+2.018(r=0.8144)
	제2소구치 : Y=3.863X+7.432(r=0.8638)		제2소구치 : Y=3.675X+7.275(r=0.8819)
	제1소구치 : Y=3.472X+7.120(r=0.8352)		제1소구치 : Y=4.001X+6.544(r=0.9024)
하악 우측	제2대구치 : Y=4.447X+7.938(r=0.8045)	하악 우측	제2대구치 : Y=4.653X+7.365(r=0.8598)
	제1대구치 : Y=5.954X+1.495(r=0.7777)		제1대구치 : Y=5.449X+2.012(r=0.7553)
	제2소구치 : Y=3.894X+7.253(r=0.8689)		제2소구치 : Y=3.772X+7.025(r=0.8719)
	제1소구치 : Y=4.189X+6.717(r=0.8370)		제1소구치 : Y=4.327X+6.193(r=0.8524)
상악 좌측	제2대구치 : Y=4.430X+7.722(r=0.7538)	상악 좌측	제2대구치 : Y=4.876X+7.606(r=0.8311)
	제1대구치 : Y=4.645X+2.886(r=0.6894)		제1대구치 : Y=6.754X+1.891(r=0.5378)
	제2소구치 : Y=4.391X+6.686(r=0.7700)		제2소구치 : Y=1.245X+10.573(r=0.1908)
	제1소구치 : Y=5.564X+6.037(r=0.9032)		제1소구치 : –
상악 우측	제2대구치 : Y=4.587X+7.966(r=0.7882)	상악 우측	제2대구치 : Y=4.454X+7.803(r=0.8443)
	제1대구치 : Y=4.047X+4.124(r=0.6352)		제1대구치 : Y=6.336X+2.911(r=0.4688)
	제2소구치 : Y=2.920X+8.089(r=0.7277)		제2소구치 : Y=3.105X+8.082(r=0.6381)
	제1소구치 : Y=3.264X+6.970(r=0.7292)		제1소구치 : –

4. Orthopantomograph상의 crown-root ratio를 이용한 연령의 추정에는 상악치아들 보다 하악치아들이 더 정확하게 사용될 수 있다.