대한구강해부학회지 2013년
34(1) : 69~91

Variations of maxillary premolars in Koreans

Department of Oral Anatomy, School of Dentistry, Chonnam National University

Hun-Kyung Park, Jin-Woo Kim, Min-Seok Kim and Sun-Hun Kim*

Introduction

Dental anatomy such as tooth morphology, dimension, dental arrangement can give us valuable information related to human dentition, population specificity, forensic dentistry and anthropology. Correct identification in dental anatomy of single human teeth, whether they are found in jaw segments or in isolation, is of great importance. On some occasions, correctly identified teeth can be conclusive in forensic dentistry. Forensic odontology demands methodical odontometric data for the identification of teeth examined postmortem.

In addition, Odontometric studies based on traditional measures of tooth size, i.e, mesiodistal (MD) and buccolingual (BL) crown diameters can provide advanced understanding of its ontogeny. Advanced digital analysis based on standized digital photography and digital imaging processing technique is attributed to active studies on odontometric research.

Butler[1] revealed that estimates of genetic and environmental contributions to the variability in overall tooth size, together with analyses of correlations between dental dimensions, have improved our understanding of the control mechanisms operating during odontogenesis.

Various qualitative and quantitative studies have been performed on characteristics and differences between two sexes or races

* 교신저자

based on ontogeny, tooth morphology, and size of teeth. Biggerstaff[2] introduced the concept of basal crown areas in an attempt to assess the variation within premolar and molar crowns generated by deviations in the size and location of indivisual crown component. Sudeendra Prabhu[3] examined sexual dimorphism in Indians with MD and BL measurments of tooth crown and reported moderate accuracy in sex prediction: the mandibular teeth can determine sex with higher accuracy (75.2%) when compared to teeth in both jaws taken together (74.3%) or using maxillary teeth (62.9%). G.C. Townsend[4] did a research on intercuspal distances and reported that no significant differences were noted between the sexes for intercuspal distances and intercuspal dimensions showed greater variability and fluctuating asymmetry.

Some studies reported that sex can be determined by measuring tooth sizes which show difference in both sexes and populations[5-8]. But other researchers have found no evidence of significant sexual dimorphism for certain dental traits[9,10].

Many tooth morphologic studies on sexual dimorphism and tooth differentiation were performed but maxillary premolar focused reports were not abundant. Moreover, it is not easy for dentists to differentiate between maxillary first premolars and second premolars unlike mandibular premolars. Additionally, population-specific data is necessary for forensic odontology and anthropology but morphometric data of maxillary premolars in Koreans is rare.

Therefore, the purpose of this study is to investigate crown size and morphologic characteristics of occlusal surface of maxillary first and second premolars among adult Koreans and to check whether there are any differences between both sexes and between maxillary first and second premolars.

Materials and Methods

A. Sample

1) Subjects

The study is performed in Cho-

nnam National University School of Dentistry in Gwangju, Jeollanam-do, South Korea. The total number of participants is 183, and the group consists of 110 men and 73 women. The average age is 28.9±3.7 (range 22.6~42.2) years of age.

2) Criteria of volunteer selection

Subjects were chosen by the following criteria:

a) intact morphology of the original form of premolars without any prothetic modification (inlay, onlay, crown etc.) on tooth.
b) no evidence of excessive tooth wear.
c) the presence of both first and second premolars in either left or right maxilla.

B. Dental cast fabrication

Dental stone casts were made with plaster within 1 hour after taking maxillary impression of participants by using alginate impression material. After obtaining dental cast, next step was to remove air bubble and then to test whether individual cusps are distinguishable. Then, cusp tips were marked by a pencil in order to make it easy to measure intercuspal distance between buccal and lingual cusp tips.

Dental casts with ambiguous cusp tips due to attrition or fracture of occlusal surface were excluded from the experiment. The experiment was mostly performed with maxillary right premolars, but maxillary left premolars were also included when there were missing teeth, heavy attrition, prosthesis, and abnormal on the right side. After excluding all types of exceptions, the number of final participants narrowed to 110 men and 73 women.

C. Standard Photograph and measurements of occlusal surface

Canon Powershot A 640 was used to shoot occlusal surfaces of maxillary first premolars and second premolars of dental casts. After setting up dental axis perpendicular to the laboratory floor, It is shot 40cm away from the occlusal surface (Fig. 1).

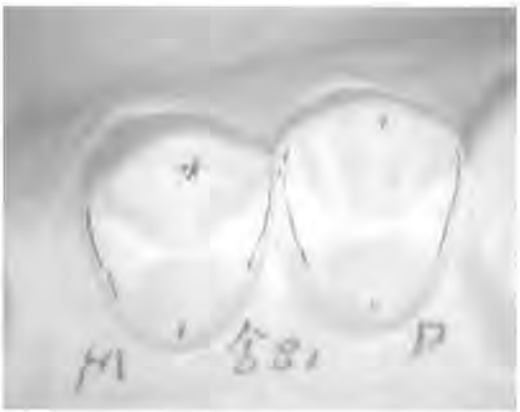

Fig. 1. Photographs of occlusal surface of maxillary premolars.

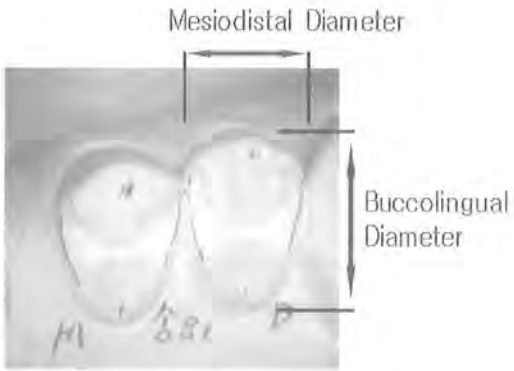

Fig. 2. MD and BL measurement.

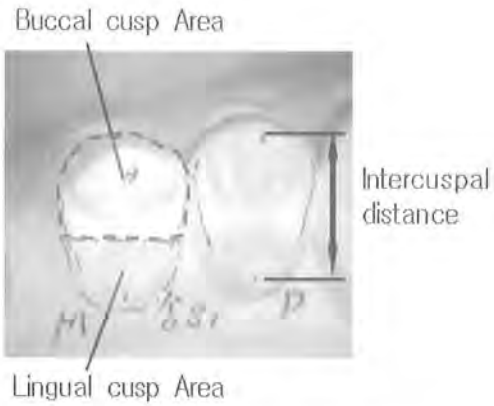

Fig. 3. ID, BC and LC area measurement.

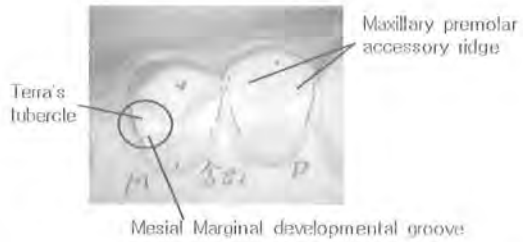

Fig. 4. Terra's tubercle, M.M.groove and MxPAR measurement.

Occlusal parameters of maxillary premolars on the photographs were measured by AxioVision LE RE1 4.4(Carl Zeiss MicroImaging GmbH) program (Fig. 2-4) as follows : 1) Intercuspal distance (ID): distance between buccal cusp tip and lingual cusp tip, 2) Buccolingual crown diameter (BL): a perpendicular distance between two tangential lines of the most prominent point of either buccal and lingual sides of crown, 3) Mesiodistal crown diameter (MD): a perpendicular distance between two tangential lines of the most prominent point of either mesial and distal sides of crown, 4) Each cusp area : Buccal cusp area (BC area) and lingual cusp area (LC area) were divided by the central developmental groove, 5) total cusp area : calculated by the sum of all cusp areas, 6) Terra's tube-

Table 1. Description of MxPAR plaque grades 7

Grade	Description
0	Absent. No detectable ridge formation.
T	Truncated ridge. Ridge does not extend continuously from the buccal ridge to the medial sulcus. Truncated ridges should be scored to size using the following grades and are not differentiated from nontruncated ridges in analysis.
1	Trace. A continuous ridge is barely discernable, but seen under strong light.
2	Small. A thin continuous ridge, yet easily palpable.
3	Medium. A continuous ridge with moderate thickness.
4	Pronounced. A large, thick, continuous ridge that dominates the locus.

Length and area are measured by respectively 0.1mm and 0.01mm^2 units.

rcle, 7) Mesial marginal groove. 8) Maxillary premolar accessory ridge. (MxPAR).

Fig. 5. MxPAR scoring plaque.

When Maxillary premolar accessory ridges were analysed, five-grade rank scale(Table 1) by Scott E. Burnett[11] which has been recently included in the Arizona State University Dental Anthropology System was adopted for visual scoring. The scale was developed to aid in analyzing of both mesial and distal accessory ridges on both first and second maxillary premolars with a single reference plaque (Fig.5).

D. Statistical Analysis

Technical statistical analysis including distribution of variables is analyzed by PASW Statistics 18 (Ver. 18.0.0 SPSS Inc, USA) SPSS software program. Difference between mandibular first molars and mandibular second molars were analyzed by paired t-test. Difference between Genders and correlation between variables are analyzed by independent t-test and Pearson's correlation test respectively. Each analysis is performed with 95% confidence interval and significant difference of $P<0.05$.

In order to check out measure-

ment errors, 40 dental casts are randomly selected and a serial of procedure of standard photography and measurements of dental casts were repeated by the second examiner. inter-observer errors were analysed by paired t-test with 95% confidence interval and significant difference of $P<0.05$.

Results

A. Comparison of Maxillary first and second Premolar.

Crown diameter (ID, MD, BL), crown area (BC area, LC area, Crown area) and percentage (BC rate, Terra's tubercle, M.M. groove) in maxillary first premolars were bigger than in second premolars except LC rate and MxPAR scores in this study. The absolute surface area of LC of first premolar is greater than that of second premolar but LC rate (the relative value of LC area) yield the contrary result.

Basic Descriptive statistics of crown diameter, cusp area, Terra's tubercle, Mesio marginal groove, MxPAR of maxillary first and second premolar in Koreans is listed in Table 2.

Intercuspal diameters of adult Korean premolars were 6.40± 0.57mm, 6.33± 0.56mm, MDs were 7.86± 0.50mm, 7.25± 0.53mm, BLs were 9.76± 0.60mm, 9.50± 0.68mm in maxillary fist premolars and second premolars, respectively.

Those crown diameter comparison between maxillary first and second premolars were shown in Fig. 6.

BC areas were 35.03± 4.25mm^2, 30.63± 3.98mm^2, LC areas were 25.09± 3.71mm^2, 24.23± 3.78mm^2, Crown areas were 60.12± 6.57mm^2, 54.87± 6.79mm^2 in maxillary fist premolars and second premolars, respectively. Maxillary fist premolars were longer and wider than second premolars in crown diameter and areas.

In Pearson correlation test, total crown area showed close correlation to several measurement parameters. Interestingly, total crown area of maxillary Premolars was more correlated to BL diameter ($r=0.840$, $p=0.000$) than MD diameter ($r=0.787$, $p=0.000$) and Intercuspal diameter ($r=0.576$, $p=0.000$). This tendency was more apparent

Table 2. Descriptive statistics of maxillary first and second premolars.

		N	Mean	S.D	t-test			
					t	p-value	confidence interval (95%)	
							Min.	Max.
crown diameter (mm)	ID (P1)	183	6.40	0.57	2.023	0.045*	0.002	0.139
	ID (P2)	183	6.33	0.56				
	MD (P1)	183	7.86	0.50	16.310	0.000**	0.540	0.689
	MD (P2)	183	7.25	0.53				
	BL (P1)	183	9.76	0.60	7.408	0.000**	0.197	0.340
	BL (P2)	183	9.50	0.68				
cusp area (mm^2)	BC area (P1)	183	35.03	4.25	18.955	0.000**	3.940	4.856
	BC area (P2)	183	30.63	3.98				
	LC area (P1)	183	25.09	3.71	4.248	0.000**	0.456	1.246
	LC area (P2)	183	24.23	3.78				
	crown area (P1)	183	60.12	6.57	16.081	0.000**	4.605	5.893
	crown area (P2)	183	54.87	6.79				
(%)	BC rate(P1)	183	58.31	3.79	9.708	0.000**	1.921	2.900
	BC rate(P2)	183	55.90	3.42				
	LC rate(P1)	183	41.69	3.79	-9.708	0.000**	-2.900	-1.921
	LC rate(P2)	183	44.10	3.42				
	Terra's tubercle(P1)	183	70.49	45.73	8.709	0.000**	30.853	48.928
	Terra's tubercle(P2)	183	30.60	46.21				
	M.M.groove(P1)	183	63.39	48.31	11.174	0.000**	39.596	56.579
	M.M.groove(P2)	183	15.30	36.10				
score	M.MxPAR(P1)	183	0.45	0.75	-11.284	0.000**	-1.528	-1.073
	M.MxPAR(P2)	183	1.75	1.47				
	D.MxPAR(P1)	183	0.78	0.95	-12.154	0.000**	-1.391	-1.002
	D.MxPAR(P2)	183	1.97	1.31				

Abbr.: ID Intercuapsl distance, MD mesiodistal diameter, BL buccolingual diameter, BC area buccal cusp area, LC area lingual cusp area. S.D standard deviation, BC rate buccal cusp rate, LC rate lingual cusp rate, M.M.groove Mesial marginal groove. M.MxPAR mesial maxillary premolar accessory ridge D.MxPAR distal maxillary premolar accessory ridge, * $p<0.05$, ** $p<0.01$

Table 3. Comparison of maxillary first and second premolars in male.

		N	Mean (mm)	S.D	t-test			
					t	p-value	confidence interval (95%)	
							Min.	Max.
crown diameter (mm)	ID (P1)	110	6.41	0.61	2.068	0.041*	0.004	0.188
	ID (P2)	110	6.31	0.58				
	MD (P1)	110	7.91	0.55	13.553	0.000**	0.559	0.751
	MD (P2)	110	7.25	0.49				
	BL (P1)	110	9.84	0.60	6.372	0.000**	0.207	0.394
	BL (P2)	110	9.54	0.70				
cusp area (mm^2)	BC area (P1)	110	35.87	4.33	16.549	0.000**	4.049	5.15
	BC area (P2)	110	31.27	4.16				
	LC area (P1)	110	25.07	3.82	3.999	0.000**	0.489	1.449
	LC area (P2)	110	24.1	3.63				
	Crown area (P1)	110	60.94	6.93	14.314	0.000**	4.797	6.339
	Crown area (P2)	110	55.37	6.90				
rate (%)	BC rate(P1)	110	58.91	3.65	8.032	0.000**	1.808	2.993
	BC rate(P2)	110	56.51	3.27				
	LC rate(P1)	110	41.09	3.65	45.666	0.000**	16.252	17.727
	LC rate(P2)	110	24.10	3.63				
	Terra's tubercle(P1)	110	70.91	45.63	7.423	0.000**	32.652	56.438
	Terra's tubercle(P2)	110	26.36	44.26				
	M.M.groove(P1)	110	60.00	49.21	7.849	0.000**	32.618	54.654
	M.M.groove(P2)	110	16.36	37.16				
score	M.MxPAR(P1)	110	0.49	0.75	-9.221	0.000**	-1.668	-1.078
	M.MxPAR(P2)	110	1.86	1.52				
	D.MxPAR(P1)	110	0.64	0.91	-10.035	0.000**	-1.470	-0.985
	D.MxPAR(P2)	110	1.86	1.34				

Abbr.: ID Intercuapsl distance, MD mesiodistal diameter, BL buccolingual diameter, BC area buccal cusp area, LC area lingual cusp area, S.D standard deviation, BC rate buccal cusp rate, LC rate lingual cusp rate, M.M.groove Mesial marginal groove, M.MxPAR mesial maxillary premolar accessory ridge D.MxPAR distal maxillary premolar accessory ridge, * $p<0.05$, ** $p<0.01$

Table 4. Comparison of maxillary first and second premolars in female.

		N	Mean	S.D	t-test			
					t	p-value	confidence interval (95%)	
							Min.	Max.
crown diameter (mm)	ID (P1)	73	6.40	0.52	0.644	0.521	-0.071	0.139
	ID (P2)	73	6.36	0.55				
	MD (P1)	73	7.80	0.42	9.268	0.000**	0.435	0.673
	MD (P2)	73	7.24	0.58				
	BL (P1)	73	9.65	0.58	3.882	0.000**	0.107	0.332
	BL (P2)	73	9.43	0.64				
cusp area (mm^2)	BC area (P1)	73	33.77	3.82	10.146	0.000**	3.290	4.899
	BC area (P2)	73	29.68	3.51				
	LC area (P1)	73	25.11	3.56	1.950	0.055	-0.015	1.364
	LC area (P2)	73	24.43	4.02				
	Crown area (P1)	73	58.88	5.80	8.369	0.000**	3.633	5.905
	Crown area (P2)	73	54.11	6.58				
rate (%)	BC rate(P1)	73	57.40	3.85	5.611	0.000**	1.564	3.287
	BC rate(P2)	73	54.98	3.46				
	LC rate(P1)	73	25.11	3.56	-46.278	0.000**	-20.773	-19.057
	LC rate(P2)	73	45.02	3.46				
	Terra's tubercle(P1)	73	69.86	46.20	4.665	0.000**	18.827	46.927
	Terra's tubercle(P2)	73	36.99	48.61				
	M.M.groove(P1)	73	68.49	46.78	8.095	0.000**	41.301	68.288
	M.M.groove(P2)	73	13.70	34.62				
score	M.MxPAR(P1)	73	0.38	0.76	-6.526	0.000**	-1.556	-0.828
	M.MxPAR(P2)	73	1.58	1.39				
	D.MxPAR(P1)	73	0.99	0.99	-6.968	0.000**	-1.480	-0.821
	D.MxPAR(P2)	73	2.14	1.24				

Abbr.: ID Intercuapsl distance, MD mesiodistal diameter, BL buccolingual diameter, BC area buccal cusp area, LC area lingual cusp area, S.D standard deviation, BC rate buccal cusp rate, LC rate lingual cusp rate, M.M.groove Mesial marginal groove, M.MxPAR mesial maxillary premolar accessory ridge D.MxPAR distal maxillary premolar accessory ridge, * $p<0.05$, ** $p<0.01$

in P1 because BL diameter of P1 (r=0.872, p=0.000) was more correlated to total crown area than that of P2(r=0.813, p=0.000). Similary crown area was much more proportional to BC area (r=0.882, p=0.000) than LC area (r=0.812, p=0.000). But buccal cusp area was more correlated to MD diameter (r=0.783, p=0.000) than BL diameter(r=0.711, p=0.000).

BC rate of maxillary fist premolars (58.31%) was bigger than that of second premolars (55.90%) but LC rate of second premolars (44.10%) was bigger than the that of first premolars (41.69%).

Terra's tubercle and M.M.groove were more frequently detected in maxillary first premolars (70.49%, 63.39%) than in second premolars (30.60%, 15.30%).

MxPARs were most frequently observed in distal locus of maxillary second premolars and most infrequent in mesial locus of maxillary first premolars. Mean MxPAR scores were marked (0.45) in mesial locus first premolars and (1.97) distal locus of second premolars, respectively.

All measurements revealed significant difference between maxillary first and second premolars, but when those were classified into male (Table 3) and female (Table 4), maxillary premolars of 73 female subjects did not show significant difference in intercuspal distance and lingual cusp areas, whereas maxillary premolars of 110 male subjects showed significant difference in all measurements.

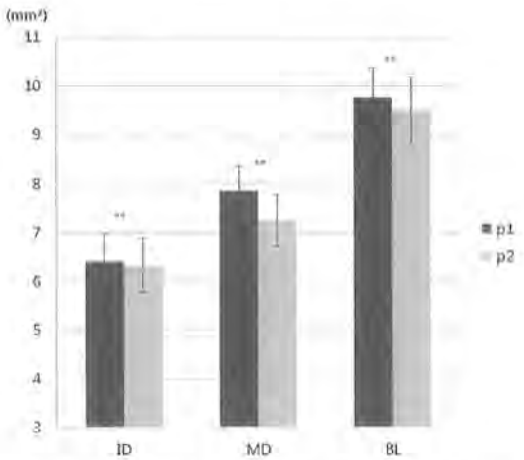

Fig. 6. Crown diameter comparison between maxillary first and second premolars. Data were represented with mean±S.D M: male F:female
** p<0.05, **p<0.01

In terms of MxPAR, ridges typified by plaque grades 2-4 may be considered present while grades 0-1 reflect absence of the trait (MxPAR) for optimal results. The

Table 5. MxPAR scores for Maxillary first and second premolars by Locus and Grade.

Locus	Grade (0-4)	absent		Present			present rate(%)
		0	1	2	3	4	
P1	Mesial	N = 126	36	17	4	0	11.48
	Distal	N = 90	57	28	3	5	19.67
P2	Mesial	N = 53	30	47	16	37	54.64
	Distal	N = 34	31	49	44	25	64.48

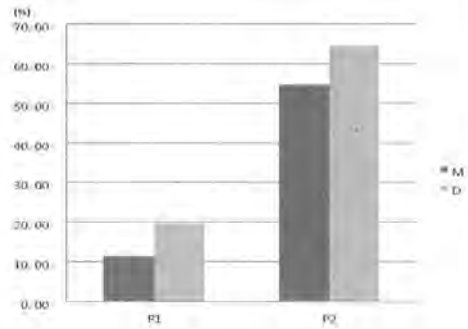

Fig. 7. Comparison of MxPAR present rate between maxillary fist and second premolars. M: mesial D: distal

results of present rate were showed in ficture 7. MxPARs were detected with more than 50% of present rate in each location of maxillary second premolars but less than 20% in maxillary first molars. Distal locus of each premolar were more frequently detected than mesial locus. MxPAR scores for Maxillary first and second premolars by Locus and Grade were shown in Table 5.

B. Gender difference

Gender difference was assessed in three groups - whole maxillary premolars, simple maxillary first premolars and simple maxillary second premolars. Gender difference in whole maxillary premolars were listed in Table 6. Overall crown diameters and areas measured in maxillary premolars were greater in male than in female but intercuspal distance and mesiodistal diameter did not show significant difference. Intercuspal distances were 6.38mm, 6.36mm and mesiodistal diameters were 7.52mm, 7.58mm in female and male, respectively. BC area, BC rate and LC rate showed stable sexual dimorphism in all three groups.

BC rate of male maxillary premolars (57.71%) was bigger than that of female maxillary premolars (56.19%) but LC rate was

bigger in female (43.81%) than in male (42.29%). Terra's tubercle, M.M.groove and M.MxPAR did not show gender difference but D.MxPAR of female maxillary premolars scored (1.56) higher than that of male maxillary premolars (1.25)($p<0.05$).

But in Table 8. which lists gender differences of simple maxillary second premolar BC area, BC rate and LC rate revealed significant gender difference consistently.

Gender difference in BC rate, BC areas, LC rate, Terra's tubercle and M.M. Grooves between maxillary premolars were graphically depicted in Fig. 8-12.

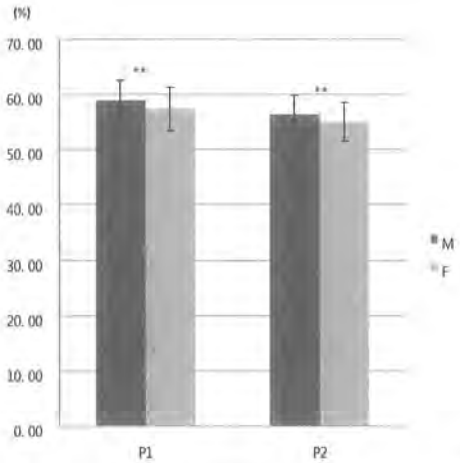

Fig. 8. Gender difference in BC rate of Maxillary premolars. M: male F: female (* $p<0.05$, ** $p<0.01$)

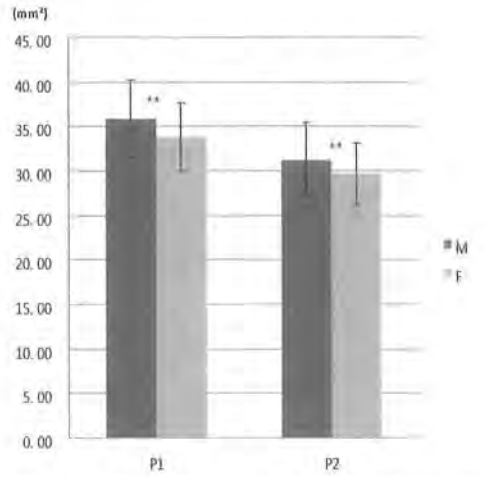

Fig. 9. Gender difference in BC areas of Maxillary premolars. M: male F: female (* $p<0.05$, ** $p<0.01$)

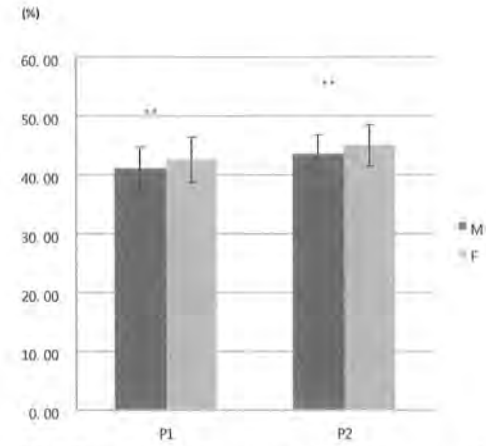

Fig. 10. Gender difference in LC rate of Maxillary premolars M: male F: female (* $p<0.05$, ** $p<0.01$)

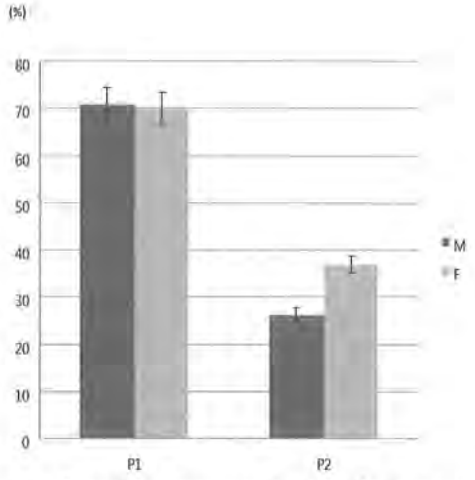

Fig. 11. Gender difference in Terra's tubercle of Maxillary premolars M: male F: female

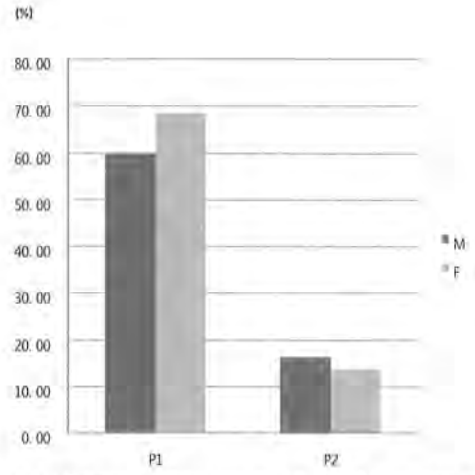

Fig. 12. Gender difference in M. M. groove of Maxillary premolars M: male

C. Interobserver Errors

After selecting 40 dental casts randomly, measurement errors were calculated by comparing first measurement values by taking photographs and performing graphic analysis of dental casts repeatedly.

Gender difference in simple maxillary first premolars were listed in Table 7. BL, BC area, Crown area, BC rate, LC rate and D.MxPAR showed significant gender difference like the former Table 6.

Paired t-test with 95% confidence interval for first and second measurements was performed and it showed no significant difference ($p<0.05$) given that there were negligible measurement errors in this study and results are reliable.

Discussion

There has been no comprehensive comparative study of tooth crown dimension in male and female where maxillary first and second premolars were compared, moreover maxillary premolar traits are under-represented in most studies of dental morphology.

The maxillary premolars are developed from the same number of lobes as anterior teeth-four. The

Table 6. Gender difference in whole maxillary premolars.

			N	Mean	S.D	t-test			
						t	p-value	confidence interval (95%)	
								Min.	Max.
ID	(mm)	F	146	6.38	0.53	0.385	0.701	-0.096	0.143
		M	220	6.36	0.59				
MD		F	146	7.52	0.58	-0.921	0.358	-0.185	0.067
		M	220	7.58	0.62				
BL		F	146	9.54	0.62	-2.171	0.031*	-0.287	-0.014
		M	220	9.69	0.67				
BC area	(mm^2)	F	146	31.73	4.19	-3.763	0.000**	-2.802	-0.879
		M	220	33.57	4.82				
LC area		F	146	24.77	3.80	0.455	0.649	-0.608	0.974
		M	220	24.59	3.75				
Crown area		F	146	56.50	6.63	-2.177	0.030*	-3.154	-0.161
		M	220	58.15	7.44				
BC rate	(%)	F	146	56.19	3.85	-3.806	0.000**	-2.301	-0.733
		M	220	57.71	3.66				
LC rate		F	146	43.81	3.85	3.806	0.000**	0.733	2.301
		M	220	42.29	3.66				
Terra's tubercle		F	146	53.42	50.05	0.896	0.371	-5.724	15.301
		M	220	48.64	50.10				
M.M. groove		F	146	41.10	49.37	0.558	0.578	-7.364	13.193
		M	220	38.18	48.69				
M.MxPAR	score	F	146	0.98	1.27	-1.388	0.166	-0.478	0.082
		M	220	1.18	1.38				
D.MxPAR		F	146	1.56	1.26	2.275	0.023*	0.042	0.581
		M	220	1.25	1.30				

Abbr.: ID Intercuapsl distance, MD mesiodistal diameter, BL buccolingual diameter, BC area buccal cusp area, LC area lingual cusp area, S.D standard deviation, BC rate buccal cusp rate, LC rate lingual cusp rate, F female, M male, M.M.groove Mesial marginal groove, M.MxPAR mesial maxillary premolar accessory ridge D.MxPAR distal maxillary premolar accessory ridge, * $p<0.05$, ** $p<0.01$

Table 7. Gender difference in simple maxillary first premolars.

			N	Mean	S.D	t-test			
						t	p-value	confidence interval (95%)	
								Min.	Max.
ID	(mm)	F	73	6.40	0.52	-0.089	0.929	-0.179	0.163
		M	110	6.41	0.60				
MD		F	73	7.80	0.42	-1.450	0.149	-0.259	0.040
		M	110	7.91	0.55				
BL		F	73	9.65	0.58	-2.129	0.035*	-0.369	-0.014
		M	110	9.84	0.60				
BC area	(mm^2)	F	73	33.77	3.82	-3.353	0.001*	-3.325	-0.861
		M	110	35.87	4.33				
LC area		F	73	25.11	3.56	0.063	0.949	-1.072	1.143
		M	110	25.07	3.82				
Crown area		F	73	58.88	5.80	-2.095	0.038*	-3.995	-0.119
		M	110	60.94	6.93				
BC rate	(%)	F	73	57.40	3.85	-2.673	0.008**	-2.615	-0.394
		M	110	58.91	3.65				
LC rate		F	73	42.60	3.85	2.673	0.008**	0.394	2.615
		M	110	41.09	3.65				
Terra's tubercle		F	73	69.86	46.20	-0.151	0.880	-14.705	12.613
		M	110	70.91	45.63				
M.M. groove		F	73	68.49	46.78	1.166	0.245	-5.882	22.868
		M	110	60.00	49.21				
M.MxPAR	score	F	73	0.38	0.76	-0.944	0.347	-0.332	0.117
		M	110	0.49	0.75				
D.MxPAR		F	73	0.99	0.99	2.462	0.015*	0.069	0.630
		M	110	0.64	0.91				

Abbr.: ID Intercuapsl distance, MD mesiodistal diameter, BL buccolingual diameter, BC area buccal cusp area, LC area lingual cusp area. S.D standard deviation, BC rate buccal cusp rate, LC rate lingual cusp rate, F female, M male, M.M.groove Mesial marginal groove, M.MxPAR mesial maxillary premolar accessory ridge D.MxPAR distal maxillary premolar accessory ridge, * $p<0.05$, ** $p<0.01$

Table 8. Gender difference in simple maxillary second premolars.

			N	Mean	S.D	t-test			
						t	p-value	confidence interval (95%)	
								Min.	Max.
ID	(mm)	F	73	6.36	0.55	0.634	0.527	-0.114	0.223
		M	110	6.31	0.58				
MD		F	73	7.24	0.58	-0.110	0.913	-0.166	0.149
		M	110	7.25	0.49				
BL		F	73	9.43	0.64	-1.080	0.281	-0.311	0.091
		M	110	9.54	0.70				
BC area	(mm^2)	F	73	29.68	3.51	-2.688	0.008**	-2.753	-0.422
		M	110	31.27	4.16				
LC area		F	73	24.43	4.02	0.577	0.565	-0.799	1.459
		M	110	24.10	3.63				
Crown area		F	73	54.11	6.58	-1.230	0.220	-3.276	0.761
		M	110	55.37	6.90				
BC rate	(%)	F	73	54.98	3.46	-3.028	0.003**	-2.527	-0.533
		M	110	56.51	3.27				
LC rate		F	73	45.02	3.46	3.028	0.003**	0.533	2.527
		M	110	43.49	3.27				
Terra's tubercle		F	73	36.99	48.61	1.528	0.128	-3.092	24.337
		M	110	26.36	44.26				
M.M. groove		F	73	13.70	34.62	-0.488	0.626	-13.440	8.110
		M	110	16.36	37.16				
M.MxPAR	score	F	73	1.58	1.39	-1.300	0.195	-0.726	0.149
		M	110	1.86	1.52				
D.MxPAR		F	73	2.14	1.24	1.389	0.167	-0.115	0.662
		M	110	1.86	1.34				

Abbr.: ID Intercuapsl distance, MD mesiodistal diameter, BL buccolingual diameter, BC area buccal cusp area, LC area lingual cusp area, S.D standard deviation, BC rate buccal cusp rate, LC rate lingual cusp rate, F female, M male, M.M.groove Mesial marginal groove. M.MxPAR mesial maxillary premolar accessory ridge D.MxPAR distal maxillary premolar accessory ridge, * $p<0.05$, ** $p<0.01$

middle buccal lobe on the premolars which corresponds to the middle labial lobe of the canines, remains highly developed, with the maxillary premolars resembling the canines. The buccal cusp of the maxillary first premolars especially is long and sharp, assisting the canine as a prehensile or tearing tooth. The second premolars have cusps less sharp than the others, and their cusps articulate with opposing teeth when the jaws are brought together. This makes them more efficient as grinding teeth and they function much like the molars. The occlusal surface of the maxillary first premolar resembles roughly a six sided or hexagonal figure but it is not equilateral. In the maxillary second premolars, the outline of the crown is more rounded or ovale, rather than angular[12]. But these two teeth resemble each other so closely that differentiation is not easy.

To analyze maxillary premolars if there are any differences between both sexes and between maxillary first and second premolars ID, MD, BL, BC area, LC area, Crown area, BC rate, LC rate, Terra's tubercle, M.M.Groove and MxPAR were measured in this study. A. B.Acharya et. al.[13] reported that dental indices such as Crown module, Crown area and Crown index offer no additional benefit in forensic sex assessment after evaluating dental three indexes . Crown module is the numerical average of BL and MD dimension, i.e. (BL + MD)/2. Crown area is the product of BL and MD dimensions and derived for each tooth by multiplying the linear measurement, i.e. BL × MD. Crown index is the ratio of two linear measurements, i.e. (BL/MD)/100. Evaluation for the three indices produced sex assessment accuracy levels lower (69.8-81.1%) to that of linear measurements (like MD, BL etc.) reported previously. A.B.Acharya et. al.[14] had reported higher classification accuracy (92.5%) for linear measurement on the same sample. So in present study dental indexes like Crown module and Crown index were not applied. Crown areas were taken by not multiplying method (BL × MD dimension) but digital imaging processing technique described above.

Crown diameter (ID, MD, BL), crown area (BC area, LC area, Crown area) and percentage (BC rate, Terra's tubercle, M.M. groove) in maxillary first premolars were bigger than in second premolars except LC rate and MxPAR scores in this study. These results of tooth size correspond with the result of previous study that later-developing teeth have reduction in overall size more frequently than earlier-developing teeth because the former are more spatially restricted[15,16]. Maxillary first premolar shows first evidence of calcification at age of $1^1/_2$ yr - $1\ ^3/_4$ yr but in second premolar at age of 2 to $1^1/_4$ yr.

Terra's tubercle and M.M.groove were more frequently detected in maxillary first premolars (70.49%, 63.39%) than in second premolars (30.60%, 15.30%). This measures show that Terra's tubercle and M.M.groove is the useful traits of maxillary first premolars to differentiate these teeth.

MxPARs were detected more frequently in maxillary second premolars than in first premolars. This result corresponds with the results of previous studies. R.W. Gilmore[17] reported that present rate of accessory ridges were 34-58% in maxillary first premolars and 50-83% in second premolars and mesial and distal accessory ridges do not occur independently as they yield linear correlation coefficient, $r = 0.546$ ($p<0.001$). In present study, the correlation coefficient was 0.536 ($p=0.000$). It is assumed that high frequency of MxPAR in second premolars is related to late initiation of calcification and the spatial restriction gives rise to supplementary grooves radiating from the central groove and makes irregular and winkled occlusal appearance thereby generating many MxPARs.

Previous investigators have found that accessory ridge frequencies vary markedly among populations that differ genetically and identical twins are more alike with respect to accessory ridges than fraternal twins[18,19]

Burnett[11] reported that statistically significant population differences were found most consistently at the distal locus on the first premolar (DP1), suggesting

that DP1 should be considered the key locus, though other loci may also be fruitful for analysis. In the report, the highest MxPAR frequencies were identified in American Chinese, Papago, Pima, Alaskan Eskimo samples while lower frequencies were found in South African Indians, American and South African Whites. The former samples exhibited frequencies from 57.0 to 80.2%, while the latter three samples exhibited much lower frequencies of 23.4-33.0%. In present study, Korean samples exhibited lower frequencies of 19.67%.

In terms of gender difference, crown diameters and areas measured in maxillary premolars were mostly greater in male than in female but BC area, BC rate and LC rate showed stable sexual dimorphism with significant difference in all three groups. In present study it should be noted that simple dental traits like BL alone can't be of great importance in sex differentiation because BL variables showed gender difference in whole maxillary premolars and first premolars groups but did not show any in maxillary second premolar group.

In this study, the average age of participants was about 30 years old and it is often challenging to analyze dental traits in this age group due to physiologic attrition of occlusal surface. Furthermore, there was a reduction in the number of participants after excluding patients with restorations for caries and missing teeth.

Under the circumstance that there has been no significant study about tooth morphology in Koreans, this study is crucial for assessment of maxillary premolars in Koreans. If further study should focus on whole tooth morphology including characteristics of tooth root, more systematic and population specific analysis could be possible.

Reference

1. Butler, P.M : Evolution an Mammalian Dental Morphology, J Biol Buccale 11:285-302, 1983.
2. Biggerstaff, R.H : The basal area of posterior tooth crown

components: The assessment of within tooth variations of premolars and molars. Am J Phys Anthrop 31:163-170, 1969.
3. Sudeendra Prabhu, Ashith B. Acharya : Odontometric sex assessment in Indians. Forensic science international 192: 129.e1-129.e5, 2009.
4. G.C.Townsend : Intercuspal Distances of maxillary premolar teeth in Australian Aboriginals. J Dent Res 64(3): 443-446, March,1985.
5. Garn SM, Lewis AB, Kerewsky RS : Sex differences in tooth size. J Dent Res 43:306,1964.
6. Rosenzweig KA : Tooth form as a distinguishing trait between sexes and human populations. J Dent Res 49(6): 1423-6, 1970.
7. Keiser JA, Groeneveld HT : Allocation and discrimination based on human odontometric data. Am J Phys Anthropol 79:331-7, 1989.
8. Krogman WM, Iscan MY : The human skeleton in forensic medicine. Charles C Thomas, Springfield, IL, 1986.
9. Turner II CG, Scott GR : Dentition of Easter islanders. In: Dahlberg AA, Graber TM, editors. Orofacial growth and development. Hague: Mouton, pp. 229-249, 1977.
10. Hanihara K : Dentition of the Ainu and the Australian aborigines. In: Dahlberg AA, Graber TM,editors. Orofacial growth and development. Hague:Mouton, pp. 195-200, 1977.
11. Scott E. Burnett, Diane E. Hawkey, and Christy G : Turner II Brief Communication: Population Variation in Human Maxillary Premolar Accessory Ridges (MxPAR). Am J Phys Anthrop 141:319-324, 2010.
12. Major M. Ash, Stanley J. Nelson : Dental anatomy, physiology, and Occlusion, SAUNDERS, pp. 215-238, 1993.
13. Acharya A.B, Mainali S : Are dental indexes useful in sex assessment? J Forensic Odontostomatol 26(2):53-59, 2008.
14. Acharya A.B, Mainali S : Univariate sex dimorphism in the Nepalese dentition and the use of discriminant functions in gender assessment. Forensic SCi INT 173(1):47-56,

2007.
15. Kondo S, Townsend GC, Yamade H : Sexual dimorphism of cusp dimensions in human maxiilary molars. Am J phys Antropol 128:870-77, 2005.
16. Takahashi M, Kondo S, Townsend GC, Kanazawa E : Variability in cusp size of human maxillary molars, with particular reference to the hypocone. Archives of oral biology 52: 1146-1154, 2007.
17. R.W.Gilmore : Epidemiology and heredity of accessory occlusal ridges on the buccal cusps of human premolar teeth. Archs oral biol. 13(9):1035-1046, 1968.
18. Kraus, B. S. The genetics of the human dentition. J Forensic Sci. 2:420-428, 1957.
19. Ludwig, F. J. The mandibular second premolars: morphologic variation and inheritance. J Dent Res. 36:263-273, 1957.

ABSTRACT

Variations of maxillary premolars in Koreans

Hun-Kyung Park, Jin-Woo Kim, Min-Seok Kim and Sun-Hun Kim*

Department of Oral Anatomy, School of Dentistry, Chonnam National University

Many tooth morphologic studies on sexual dimorphism and tooth differentiation were performed but maxillary premolar focused reports were not abundant. Furthermore, population-specific data is required for forensic odontology and anthropology but morphometric data of maxillary premolars in Koreans is rare. Therefore, the purpose of this study is to investigate crown size and morphologic characteristics of occlusal surface of maxillary first and second premolars among adult Koreans and to check whether there are any differences between both sexes and between maxillary first and second premolars.

Data were obtained from 183 dental casts of adult Korean (110 males and 73 females). Intercuspal distance (ID), Mesiodistal crown diameter (MD), Buccolingual crown diameter (BL), Buccal cusp area (BC area), Lingual cusp area (LC area), Crown area, Terra's tubercle, Mesial marginal groove (M.M.Groove) and Maxillary premolar accessory ridges (MxPAR) were measured using digital image analysis system. Paired t-test, independent t-test and Pearson's correlation test were performed to analyze differences, tendencies and correlations using SPSS program.

Generally, maxillary first premolars were bigger than second premolars with significant differences. This is because second premolars have greater spatial restrictions than first premolars when space is needed for development.

In terms of gender difference, most crown diameters and areas measured in maxillary premolars were greater in male than in female but BC

area, BC rate and LC rate showed stable sexual dimorphism with significant difference in all three groups consistently.

Hence, it is recommended that several tooth variables should be used together when sex assessment are performed.