Mandibular Clinical Arch Forms in Koreans with Normal Occlusions

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The purpose of this study was to clarify morphologic characteristics between mandibular clinical arch forms in Koreans with normal occlusions. The study included data from 102 Koreans. The most facial portion of 13 proximal contact areas was digitized from photocopied images of the mandibular dental arches. Clinical bracket points were calculated for each tooth based on mandibular tooth thickness data. Four linear and two proportional measurements were taken. The dental arches were classified into ovoid, square and tapered forms. The frequency distributions of the three mandibular arch form classifications were determined and compared between male and female subjects. No significant differences in arch form size were found between the sexes. However, there were a few differences in molar width. It was useful to classify mandibular clinical arch forms present in normal occlusion samples into ovoid, square and tapered categories. The frequency of the ovoid form was the highest, and that of the square form was the second highest. The tapered arch form was found in less than 10 percent of subjects. No significant differences in their frequency distributions and dimensions were shown between males and females.

Key words : Normal occlusion, Arch form, Arch wire, Clinical bracket position

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The identification of a suitable arch form for the treatment of each malocclusion is a key aspect in achieving a stable, functional, and esthetic arch form. Failure to customize the arch form would create the probability of relapse and can lead to an unnatural look to the smile.[1-4] The application of a single ideal arch form

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for every member of an ethnic group, despite individual variations, may also adversely affect posttreatment occlusal stability.[1,5-7] Therefore, it is important, in the leveling and alignment stage, to select the shape that most closely matches the patient's pretreatment arch form according to both their type of malocclusion and ethnic group.

The process of individualizing arch forms from the original mandibular arch has become more popular.[8-10] Many recent studies have used normal untreated samples for determining arch form mathematically, as demonstrated by Kwon, et al and Kim.[11,12] Both Nam and Lee[13] and Lee and Park[14] conducted research for characterizing arch form through various measurements using the incisal edges and cusp tips as landmarks. Recently, authors have reported that they have determined a tooth's clinical bracket point by mathematical estimation from the most facial portion of the proximal contact area and used this as a landmark for mandibular arch form assessment.[10,15] This method seems to offer a great clinical value for modern orthodontics that frequently uses preformed superelastic arch wires.

Clinically, instead of using one type of preformed arch form, it is more reasonable to have several types of preformed arch wires available and to identify the patient's arch form of normal occlusion. The clinician should be aware of the characteristics of the mandibular clinical arch forms of normal occlusion to understand how to best approach treatment of malocclusion. Therefore, the purpose of this study was to determine the morphological dimensions within mandibular clinical arch forms and clarify the frequency distribution of ovoid, square and tapered arch forms in Koreans with normal occlusions.

MATERIALS AND METHODS

The data base for this study consisted solely of Korean samples. The Korean normal occlusion group was made up of 102 cases (21.7 ± 1.9 years) which were obtained from the Departments of Orthodontics of Wonkwang, Dankook, and Chonbuk Universities, Korea. Participants included 47 females (21.4 ± 1.1 years) and 55 males (22.1 ± 1.8 years). Study models and cephalometric X-rays were taken. All cases had to meet 7 inclusion criteria, the most important being a Class I canine and molar relationship.[16]

The occlusal surfaces of the mandibular models were photocopied next to a ruler for magnification correction. The photocopied images were placed on a digitizer and the most facial portions of 13 proximal contact areas around the arch were digitized (Fig 1). These points are used to estimate corresponding bracket slot locations (clinical bracket point) for each tooth. The proximal contact between the 2 central incisors was used as the origin of the XY coordinate.

The original XY coordinate on the digitizer was corrected for magnification and adjusted to establish a new X'Y'coordinate in such a way that the mean inclination of straight lines connecting the right and left contact points between the first and second premolars and those between the second premolars and first molar became parallel to the original X axis. A line perpendicular to the lines connecting the mesial and distal contact points of each tooth on the coordinate was drawn from the midpoint of the mesiodistal line for the incisors, canines, and premolars and from the mesial third for the molars. The perpendicular line was extended labially or buccally to locate a clinical bracket point for each tooth based on the mandibular tooth thickness data by Andrews.[17]

The following 4 linear and 2 proportional measurements were taken (Fig 2); Intercanine width: the distance between the canine clinical bracket points; Intermolar width: the distance between the first molar clinical bracket points; Canine depth: the shortest distance from a line connecting the canine clinical bracket points to the origin between the central incisors ; Molar depth: the shortest distance from a line connecting the first molar clinical bracket points to the origin between the central incisors; Canine W/D ratio: the ratio of the intercanine width and the canine depth; Molar W/D ratio: the ratio of the intermolar width and the molar depth.

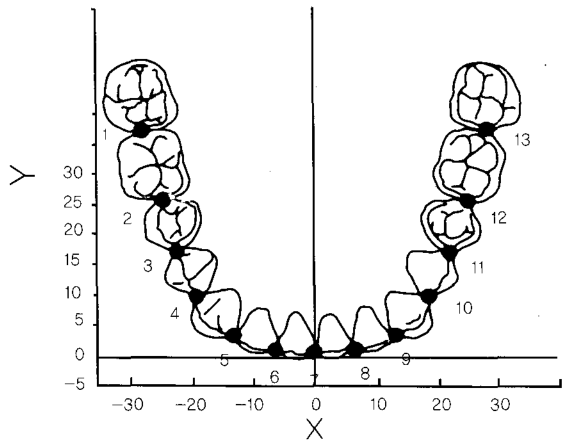

Fig 1. Points digitized on an image of mandibular teeth. These points represent the most facial portions of 13 proximal contact points.

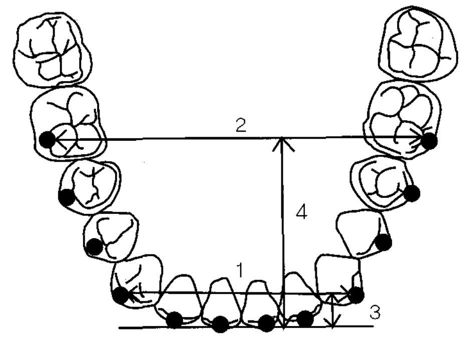

Fig 2. Twelve clinical bracket points and 4 linear and 2 proportional measurements of arch dimensions. 1. intercanine width; 2. intermolar width; 3. canine depth; 4. molar depth

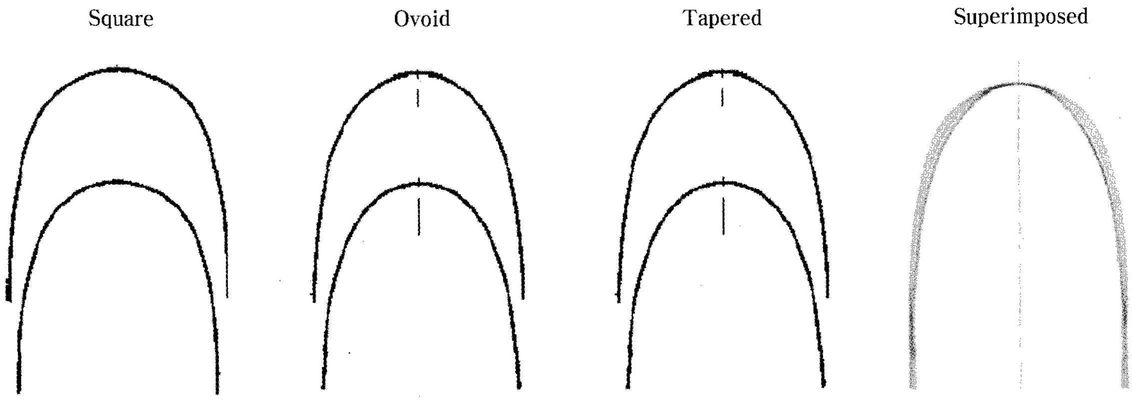

Fig 3. Three basic arch forms and superimposed image

Twelve clinical bracket points from each individual sample were printed to full size to determine which arch form, square, ovoid, or tapered (OrthoForm, 3M Unitek, Calif), they matched. Their respective arch forms were selected based on the arch form that best fit the 8 clinical bracket points from right first premolar to left first premolar (Fig 3).

Statistical Analysis

The chi−square test and Fisher's exact test were used to assess the association between arch form distribution and gender. Various arch dimensions for both male and female samples were compared for differences using the unpaired t−test and the Wilcoxon Rank Sum test. All analyses were tested at the significance level of 0.05.

The measurement error was assessed by statistically analyzing the difference between duplicate measurements taken at least 2 weeks apart on 24 casts selected at random. The measurement errors were generally small (less than 5% of the measured mean value) and within acceptable limits.

Table 1. Mean, standard deviation, and median values of mandibular arch dimensions in Koreans with normal occlusion

Variable	Total(102)		Male(47)			Female(55)		
	Mean	SD	Mean	SD	Median	Mean	SD	Median
Canine width	29.92	1.37	30.04	1.49	30.08	29.81	1.26	29.79
Molar width	50.66	2.35	51.28	2.28	50.80	50.12	2.30	50.04
Canine depth	5.82	0.98	5.85	1.09	6.05	5.79	0.87	5.87
Molar depth	25.68	1.99	25.74	2.12	26.17	25.63	1.89	25.83
Canine width ratio	5.29	0.95	5.32	1.11	5.07	5.26	0.79	5.13
Molar width ratio	1.98	0.16	2.00	0.16	1.98	1.97	0.16	1.93

Table 2. Comparison between the arch form dimensions of male and female in Koreans with normal occlusion

Variable	Unpaired t-test *P*-value	Wilcoxon Rank-Sum test *P*-value
Canine width	0.4079	0.4166
Molar width	0.0130*	0.0139*
Canine depth	0.7302	0.5682
Molar depth	0.7641	0.7960
Canine width ratio	0.7621	0.8116
Molar width ratio	0.2529	0.1387

$*P<0.05$

RESULTS

Tables 1 and 2 depict the arch dimension measurements and an analysis of the differences. Of the measurements, the female group differed from the male group only in that it showed a significantly smaller molar width. Tables 3 and 4 show the frequency distributions of the 3 arch forms and the results of the chi-square test for the two gender groups.

In the total sample, ovoid arch form comprised 49.02 % of the sample, while the square and tapered arch forms made up 42.16 and 8.82 % respectively. The female group had a higher percentage of ovoid forms than the male group. Males had a higher percentage of square and tapered arch forms.

The most frequent arch form seen was the square arch form in the male group and the ovoid in the female group. The least frequent arch form for each group was the tapered. However, all differences between the male and female groups were not significant because the P-value was only 0.4685 or 0.5067 respectively using chi-square test and Fisher's exact tests.

Table 3. Frequency distributions of the three arch form types by gender in Koreans with normal occlusion

Arch Type		Female	Male	Total
Ovoid		30	20	50
Square		21	22	43
Tapered		4	5	9
Total	Frequency	55	47	102
	%	53.92	46.08	100

Table 4. Statistical analysis of frequency distribution differences between gender in Koreans with normal occlusion

Statistics	DF	Value	Prob
Chi-Square	2	1.5162	0.4685
Fisher's Exact Test			0.5067

A digitized mandibular clinical arch form for Koreans with normal occlusion was made with a 12th degree equation which was based on 13 clinical bracket points (Fig 4). The comparison between the female and male groups is illustrated in Fig 5. The equation for Korean normal occlusion is as follows:

$$y=-0.001865x^{12}-0.000128226x^{11}+0.0338x^{10}+0.001604045x^{9}-0.229081073x^{8}-0.006416573x^{7}+0.71722169x^{6}-0.0087365x^{5}-0.9842475501x^{4}+0.000045167x^{3}+0.690226659x^{2}-0.0063884x.$$

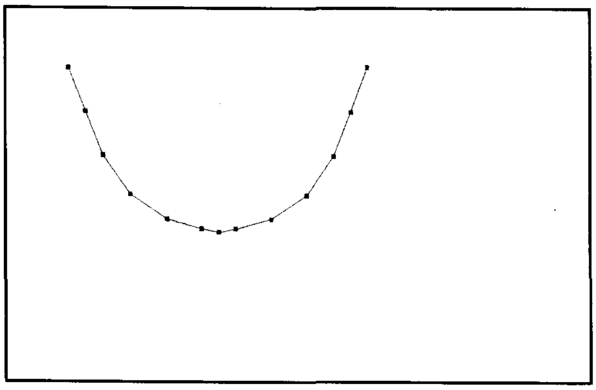

Fig 4. Digitized mandibular clinical arch form for Koreans with normal occlusion.

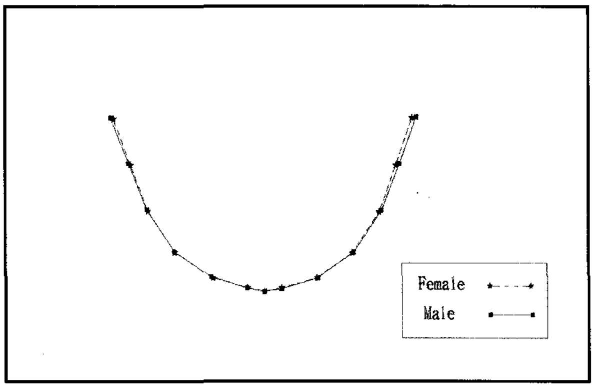

Fig 5. Digitized mandibular clinical arch forms compared between gender in Koreans with normal occlusion.

DISCUSSION AND CONCLUSIONS

The mandibular dental arch is considered as the major reference element of diagnosis and therapy in treating malocclusion cases. The stability of the form and dimension of the dental arch is an important factor in the stability of treatment results.[18]

With the widespread use of superelastic wires, it may be more clinically appropriate and accurate to recognize the ethnicity and type of malocclusion, and to select the most suitable arch from based on the patient's pretreatment arch from, to achieve a stable, functional and estheti result. Clinical bracket points corresponding to a bracket slot were used in this study following the recent method described by a previous report.[10] From the standpoint of clinical orthodontics, this method seems to offer greater value for modern orthodontics with the frequent use of preformed superelastic archwires compared to the conventional method using the incisal edges and cusp tips as landmarks.[13,14]

Raberin et al reported that the idea of a single, ideal arch form could not be substantiated in their sample of untreated adults with a normal dentition and also that there were no differences between males and females. They found two trends of arch forms including relatively stretched arches characterized by the narrow and pointed forms and relatively stocky arches illustrated by the wide, mid and flat forms.[5]

Braun et al tested 33 popular preformed nickel titanium arch wires on the relevant maxillary and mandibular natural forms. The average mandibular natural human arch form first molar/canine width ratio is 2.38/1; the same preformed arch wire/bracket ratio is 1.87/1. The corresponding mandibular first molar arch wire exceeded the natural human first molar arch width by 0.84 mm. These findings have implications with respect to posttreatment stability and facial esthetics.[19]

Felton et al reported results of a study using 17 commercial arch forms to find the best fit for normal and Class I and II malocclusion samples. They found that the most suitable arch forms were "Vari-simplex" and " Par" arches which fit over 50% of the cases.[1]

With the advent of nickel titanium highly elastic preformed arch wires, the clinician often fails to recognize a particular patient's unique arch from and size due to the confusing variability in arch form classification encountered in clinical practice. The present study followed OrthoForm methodology by classifying mandibular arches into square, ovoid, and tapered arch forms in order to determine the frequency distribution of the 3 arch forms for Koreans with normal occlusion.

Fig 5 superimposes arch forms for the male and female groups. These superimpositions clearly demonstrate that there are almost no differences between genders (Table 2). The exception is the intermolar width. These findings are very similar to those of Raberin et al.[5]

The digitized mandibular clinical arch form in Koreans with normal occlusion was made with a 12th degree equation which was based on 13 clinical bracket points. The polynomial function used in this study enables clinicians to trace curves through the thirteen reference points. This equation was designed to reproduce the normal arch form that is most similar to the individual Korean mandibular clinical arch form. This normal arch form is used by the clinician as a guide in order to treat a patient's malocclusion.

For the male arch forms, the frequency of the square arch form was the highest, followed by ovoid and then by tapered arch forms. However, the female group was composed mainly of the ovoid arch type. Despite this apparent difference, analysis showed no significance to the variation in proportion of arch forms between male and female groups.

This study demonstrates that when treating Korean patients one should expect to use ovoid or square arch forms in a significant percentage of cases. When the normal occlusion group is compared with a malocclusion group, the ovoid arch form is more prevalent and the tapered arch form is relatively less common.[20]

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국문초록

한국인 정상교합자의 하악 치열궁 형태

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본 연구의 목적은 한국인 정상교합자에서 하악치열궁의 형태적 차이를 알아보고자 하였다. 한국인 102명의 정상교합자를 대상으로 하악 모형의 교합면을 복사한 후 13개의 접촉점중에서 가장 협측으로 위치한 부분을 digitize하였고 각 치아의 브라켓위치에 해당하는점을 하악치아의 두께에 의거하여 4개의 선계측과 2개의 비율을 측정하였다.

치열궁의 형태를 square, ovoid, tapered from으로 분류하여 그 빈도를 남녀성별에 따라 비교한 결과 특이한 차이점을 보이지 않았으나 대구치간 폭경에서는 남녀성별의 차이를 보였다. 정상교합자에서 치열궁 형태분포는 ovoid, square, tapered순 이었고 tapered arch from은 10%미만이었다. 치열궁 형태의 빈도분포에 있어서 남녀간의 차이는 없었다.

주요 단어 : 정상교합, 치열궁형태, 호선, 브라켓위치

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