# A STUDY ON THE NORMAL DENTAL ARCH FORM
# OF KOREAN ADULT.

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## 韓國人 成人의 正常 齒列弓 形態에 關한 硏究

서울大學校 大學院 齒醫學科 矯正學 專攻
&lt;指導敎授 趙 喜 園&gt;

**鄭 夏 翊**

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正常 齒列弓에 관한 연구는 많은 學者들에 의해 施行되어온 바 學者들 間에는 아무런 一關性이 없다는
意見과 齒列弓을 代表할 만한 幾何學的 曲線이 存在한다는 의견이 상충되어 왔다. 그중 후자의 이론이 支
配的인 것으로 보이나 그 중에서도 曲線의 形態에 關하여서는 다시 많은 論難이 있었다.

Bonwill과 Hawley등에 의한 Circle論, Black의 半惰圓論, Angle의 抛物線論, 이외에도 많은 의견이
있는 가운데 著者는 正常咬合을 유지하는 韓國人 成人을 對象으로 Bonwill과 Hawley의 理論을 기초로 한
연구를 시행한 바 다음과 같은 結果를 얻었다.

1. 正常咬合을 유지하는 韓國人 成人의 齒列은 前齒에 있어서 圓弧에 근사한 배열을 갖는다.

2. 원의 지름은 6전치의 폭경의 합에 對하여 多樣하므로, 전치 배열이 치아의 크기에 엄격히 連關됐다고
   단정할 수는 없다.

3. 그러나 6전치 폭경의 合에 대한 원의 지름의 비율은 그 평균치가 上下顎 모두 1 : 1에 매우 근접하고
   이 事實은 Bonwill의 結論에 부합한다.

4. 犬齒間 幅徑과 臼齒間 幅徑은 六前齒의 合에 대한 비율이 上下顎에 있어서 그 형태가 다름에 따라 相
   異하나 비교적 一定하게 나타난다.

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## INTRODUCTION

In medical field, "normal value" is prerequisite for diagnosis, treatment planning, and post-treatment assessment as a criterion. In dentistry, however, many investigators have tried to figure out the standards of every details, and there have been so many disputes about normal arch form that it is not an easy thing to accept one as an orthodoxy.

At first, investigators studied arch form in hopes of improving prosthodontic appliances, then as orthodontics advanced, it became to be recognized as vital element in treatment planning and as a guide in final arch arrangement. Some insisted that there is no consistency in nature and that human dental arch varies so widely among individ-

uals. On the other hand, many authors have claimed that there may be a standard form of dental arch and some geometric curve should be fit to it.

Graber[1] said "Ideal occlusion is possible only in artistic full denture creation of the prosthodontist. For the orthodontist, ideal occlusion is admirable goal but is usually a therapeutic impossibility." But this statement does not seem to imply the uselessness of ideal occlusion, rather impress the importance of it.

Bonwill[2] has reported valuable articles about geometric principles of jaw movement and concept of ideal occlusion. He concluded that the six front teeth are arranged in an arc of circle which has its radius equal to combined width of the central and lateral incisors and canine teeth. From this idea Hawley[3] completed "Bonwill-Hawley's arch form chart" in 1904
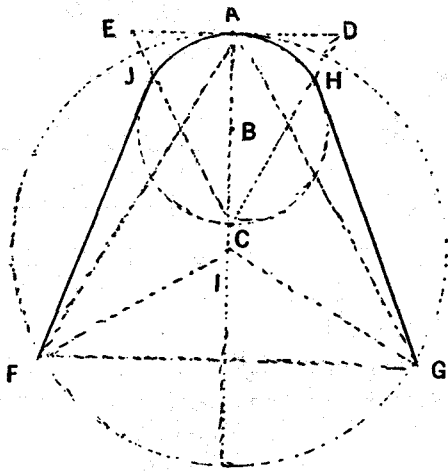


**Fig. 1.** Illustration of arch form chart drawn by Hawley. The circle of anterior arch contour(AHC) was constructed from combined width of central, lateral Incisors and canines.

(Fig. 1).

In orthodontics he realized the impossibility of direct application of Bonwill's theory to orthodontics, because intercondylar width can't be measured easily in living human being. Therefore, Hawley expressed the opinion that only available criteria should be sought in widths of anterior teeth.

In 1917, Williams[4] described the arrangement of anterior teeth as lying on the arc of circle with its center on midway between the grooves of first molars and he said the radius of this circle is determined by the combined width of permanent teeth from the buccal grooves of one first molar to that of the other.

Black[5] said that upper and lower arch forms are semi-ellipse, but their sizes are different from each other.

Angle[6] described the form of "Line of occlusion" to be similar to parabolic curve. He rejected to accept Hawley's chart and wanted to leave it to nature that will finally abjust to normal.

Stanton[7], pointing out errors in Bonwill-Hawley's method, advocated that arch forms are open and closed curves; ellipse, parabola, and kindered curves.

Izard[8] observed ellipse, parabola, and "V" or square shapes distributed in certain ratio among dental arches.

Rencently James H. Currier[9], using computerized data, concluded that arch forms varied depending on the position of points which consisted the curve, ellipse has a better goodness of fit to the outer curve of upper and lower arch and parabola has a better goodness of fit to the middle curve, while neither of them seems to exhibit a signficant fit to inner curve of both arches.

There are several reports about arch form of Korean presented by Cha,[10] Cho[11], Woo[12] and others, mostly classified into three types of U, O, and V shapes by Hamano's[13] method. However they could not present standard data of normal arch form.

In clinical view, many of orthodontists seem to adopt Bonwill-Hawley's arch form chart as a guide in ideal arch construction. Tweed[14] described it precisely in his textbook. Chuck[15], though he suggested a modification of Bonwill-Hawley's chart in order to compensate for bracket and band thickness and recommended not to regard it as a strict rule, agreed that it is useful in constructing symmetrical arch wires which then should be altered to fit to patient individually.

In the hope of being any help to science of orthodontics, theoretically or clinically, the author studied about anterior teeth alignment of normal arch of Korean adult upon the base of Bonwill's circle theory and relations between anterior teeth sizes and inter-canine or intermolar width.

## MATERIALS AND METHOD

The samples to be evaluated in this study consists of 83 cast models of Korean adult selected from 658 sets of model which were accumulated in Department of Prosthodontics, Seoul National University.

Each pair of upper and lower casts was selected on the condition that it should possess proper occlusion and full set of teeth without considering wisdom teeth.

The widths of six anterior teeth of each model were measured with Korkhaus tridimensional caliper and they were combined to yield combined mesiodistal width of six anterior teeth. (This would be abbreviated as combined width throughout this study). Black points were made on incisal edges of central and lateral incisors and on cusptips of canines, then in central fits of first molars of each model.

Intercanine width was determined as distance between two cusp-tips of canines, and inter-molar width as distance between central fits of right and left first molars. Curves of anterior teeth alignment were drawn from print made by Ricopy machine. This
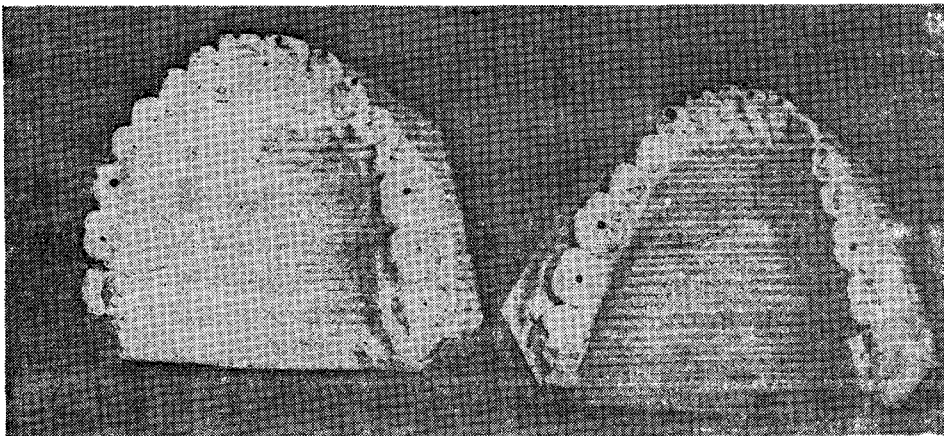


Fig. 2. Photograph showing the print of the model made by Ricopy machine

method was recommended by Inder and Bhim[16] for its simplicity and accuracy.

The cast model was laid with it teeth downward upon glass table of copy machine (Sindo Ricoh E.R. B.S.1 type), then copy obtained (Fig. 2).
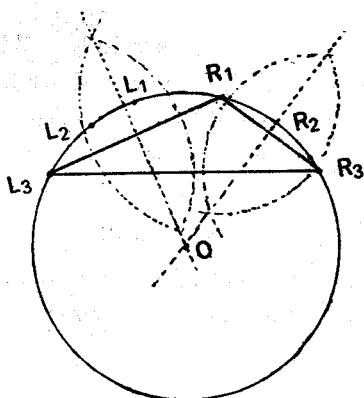
The points made before were transferred to transparant paper and circle that passes through the points of anterior teeth was drawn by taking points of two canines and one central incisor as reference (Figure 3). Because the models of this study are regarded as a normally arranged one, it does not make any difference which one of two cent ral incisors is taken as reference with canines in constructing the circle.

With a hypothesis that if anterior teeth are arranged on an arc of circle, then lateral incisors will also properly be positioned on circle drawn from those three points, and that if they are not arranged on an arc of circle, then lateral incisors should be deviated from this circle, the distance between lateral incisors and circles were measured.

**Fig. 3.** Circle drawn from triangle of one central incisor and two canines. $L_1, L_2, L_3, R_1, R_2$, and $R_3$ stand for left central, left lateral, left canine, right central, right lateral, and right canine. Circle drawn from triangle $L_1, R_3$, and $L_3$ would be just the same as above one if teeth are normally aligned.

The degree of this distance was classified into four grades.

1) 0 or nearly 0 mm.

2) 0 to 0.5mm.

3) 0.5 to 1mm.

4) over 1mm.

and samples were classified into three groups,

1) samples that have right lateral incisor deviated only,

2) samples that have left lateral incisor deviated only,

3) samples that have both lateral incisors deviated.

In cases of samples that have both lateral incisors deviated, their distance are summed up then devided in two, then this mean distance is presented as a representative for that case.

The numbers of samples were counted in these four grades and three groups. The ratio of radius of circle to combined width, of intercanine-width to combined width and of inter-molar width to combined width were calculated in each model and then their mean values were evaluated.

## RESULT

The result of upper calculation is shown below in Table I, for degree of goodness of fit of circle to arch, Table II for mean ratio and standard deviation.

**Table I.** Number of the samples that include deviated lateral incisors.

| Deviation Grade \ Group | Upper arch | | | Lower arch | | |
|---|---|---|---|---|---|---|
| | Left | Right | Both | Left | Right | Both |
| 0 | — | — | 45 | — | — | 59 |
| 0 – 0.5mm | 4 | 9 | 11 | 5 | 7 | 2 |
| 0.5 – 1.0mm | 2 | 3 | 1 | 6 | 1 | 1 |
| over 1.0mm | 3 | 1 | — | 1 | 1 | — |

Total : 83

**Table II.** Mean ratios of radius of circle, intercanine width, and intermolar width to combined width and their standard deviations.

| | Upper arch | | Lower arch | |
|---|---|---|---|---|
| | Mean | S.D.* | Mean | S.D. |
| radius of circle to combined width | 0.997 | 0.120 | 1.077 | 0.171 |
| intercanine width to com bined width | 0.700 | 0.072 | 0.751 | 0.062 |
| intermolar width to com bined width | 1.076 | 0.082 | 1.230 | 1.086 |

* S.D.; standard deviation.

## DISCUSSION

Measurement of distance of deviated lateral incisors from the arc of circle revealed that arc of circle closely fits to anterior arch contour of Korean adult. Among 83 pairs of dental models, 45 of maxillary arch and 59 of mandibular arch showed complete resemblance of arch contour to circle.

Only 1 out of 83 showed severe deviation of both lateral incisors and 11 out of 83 showed moderate (0—0.5mm) deviation in maxillary arch.

And 1 out of 83 showed severe deviation and 2 out of 83 showed moderate deviation of both lateral incisors in mandibular arch.

The author interpreted the cases that have only one lateral incisor deviated as result of erroneous choice of samples and permitted them to be included in circular group. With this in mind, samples that show curves other than circle for their arch alignment take only small portion of entire sample size.

Mean ratio of radius of circle to combined width are 0.997 in maxillary arch and 1.077 in mandibular arch. Though their mean values are closely conforms to Bonwill's conclusion, their standard deviations too big to be ignored. This fact may imply the possibility that there would be some other more important factors in constructing anterior arch form than sizes of teeth, but does not exclude the role of teeth size completely.

## CONCLUSION

The following conclusions seem to be warranted from this study.

1) The circle seems to fit to curve of anterior teeth alignment of normal arch in Korean adult.

2) The radius of circle varies so widely, especially in mandibular arch that form of teeth alignment does not seem to be related strictly to size of teeth.

3) However mean values of ratio of radius of circle to combined width are almost close to in both arch.

4) Mean ratio of intercanine width and intermolar width to combined width are different among upper and lower arch as form of two arch varies each other.

## SUMMARY

Many geometric curves are presented as representative form of normal dental arches by many authors; circle, ellipse, parabola or catenary curve.

Among them those except circle seems difficult to be adopted as a guide in ideal arch form construction and practically many orthodontists chose circle as a standard. Author preferred circle of Bonwill's theory in study of anterior teeth alignment of Korean adults.

Eighty three dental models which possess proper occlusion and good arch form were selected and copies of their occlusal surfaces obtained by Ricopy machine.

The use of Ricopy machine made it possible to draw arch form exactly.

Mesiodistal widths of six anterior teeth were measured and they were added to combined mesiodistal width of six anterior teeth.

Circle, that include the points of two cuspal tips of canines and one incisal edge of central incisor were drawn. Distances of lateral incisors that are deviated from arc of this circle were measured and classified into four grades by degree and three groups by kind of teeth deviated.

By counting the number of samples involved degree of fit of the circle to arch contour of Korean adult was described. Then, size of radius of circle, intercanine width and intermolar width were measured and evaluated their ratios to combined mesiodistal width of six anterior teeth.

In normal occlusion of Korean adult anterior teeth seems to be arranged on an arc of circle the radius of which is similar to combined mesiodistal width of six anterior teeth.

Intercanine width and intermolar width have rather constant ratios to combined width of six anterior teeth.

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