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# THE ROLE OF VERTICAL ANGULAR COMPONENTS IN SKELETAL MANDIBULAR EXCESS AND MANDIBULAR DEFICIENT PATIENTS

## 골격적으로 하악골 과잉성장이나 결핍을 갖는 환자에서 수직적 계측 항목들의 역할

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# 국 문 초 록

## 골격적으로 하악골 과잉성장이나 결핍을 갖는 환자에서 수직적 계측 항목들의 역할

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이 연구의 목적은 정상 그룹, 심하게 후퇴된 하악각 그룹, 돌출된 하악 그룹으로 이루어진 세 개의 다른 그룹들에서 수직적, 골격적 각 성분의 차이를 평가하기 위해 시행하였다. 조선대학교 교정과에 내원한 환자중 90개의 측면두부방사선계측사진을 검사하여 턱의 전-후 위치에 따라 3개의 그룹으로 나누었다. 그룹 Ⅰ은 잘 균형된 얼굴을 갖는 30명의 학생들로 구성되었다. 그룹 Ⅱ는 심하게 후퇴된 하악을 갖는 30명의 성인 환자로 구성되었으며, 그룹 Ⅲ는 심하게 돌출된 하악을 갖는 성인 환자로 구성되었다. 측면두부방사선사진들은 투사하였고, 각각 Quick Ceph 2000을 사용하여 Ricketts, Steiner, Down, 그리고 Jarapak 분석에 따라 평가하였다. 세 그룹간의 수직적 각 성분의 수치들의 차이점을 알아보기 위해 ANOVA로 통계 분석하였다. 우리는 골격적으로 하악이 과잉이거나 결핍된 환자에서 수직적 각 성분중 articular angle과 lower gonial angle이 중요한 role로 작용한다는 것을 발견했다. 그러나 saddle angle과 maxillary height angle은 그렇지 않았다.

# I. INTRODUCTION

The mandible helps define the appearance of the face as well as plays an integral role in the functions of speech and chewing. However, the mandible may develop abnormally and deviations in growth typically result in facial asymmetries. Nearly 40 years ago, Bjork[22] showed that the direction of mandibular growth in humans was extremely variable. While the normal pattern of condylar growth is vertical, extreme forward and backward patterns are presented, producing malocclusion that are difficult to treat conventionally. Severe prognathia mandibular and severe retrognathia mandibular are severe enough that the possibility of surgical intervention would have to be considered. All of the problems that all into the dentofacial deformity category, mandibular deficiency is the most prevalent. And the impact of mandibular prognathism or mandibular excess on perceived qualify of life is reflected in the number of these individuals who seek treatment. Mandibular excess is an important in the development of skeletal class Ⅲ problems.

The cephalometric obviously is one of the most important of all of the contribution made so far to the study of growth and development and to the science of orthodontics in general. Development of cephalometrics in dentistry in 1931 with Dr. Broadbent[1] developed a new method for standardizing cephalometric radiograph.

Cephalometric radiographs are an integral part of orthodontist records, being used primarily in diagnosis, treatment planning, and in the evaluation of case progression.

Recently, most clinicians obtain essential data from these radiographs through the

use of manual tracing (Gottlieb, Nelson, and Volges 1990). However, the relatively recent development of computerized software has allowed an increasing number of orthodontists to utilize this technology by digitally recording craniofacial landmarks and permitting computer programs to calculate the desired measurements. And an important aspect of comprehensive orthodontic therapy is managing the vertical dimension of patients face.

In this article, we applied computerized cephalometric analysis after manual tracing to find the relationship of skeletal vertical components of patients who have extreme mandibular growth.

The purpose of this study is to compare the vertical angular components of craniofacial structure of subjects with mandibular excess, Class III skeletal, malocclusion and mandibular deficiency or Class II skeletal, malocclusion and normal mandibular to find which angular will play an important role in the change of mandibular abnormal growth.

# Ⅱ. MATERIALS AND METHODS

All of patients with abnormal mandibular growth were collected from the Department of Orthodontics, Chosun University Dental Hospital during the years of 1999 to 2004 and images of patients who were admitted to the Department of Orthodontics for treatment of various malocclusion. Among these patients there were only a total of 60 patients suitable for the investigation as there were several criteria such as:

1. No prior orthodontic treatment
2. Adult patients with completed growth.
3. No history of severe medical illness, absence of traumatic injuries.
4. Absence of pathology such as cleft palate or genetic syndromes or other craniofacial anomalies.
5. Total eruption of upper and lower first molar
6. Extreme growth of Mandible
7. Normal growth of Maxilla

The experimental group was divided into two subgroups: (Table 1)

1) Group II included 30 patients with severely retrognathic mandible.

2) Group III included 30 patients with severely prognathic mandible

A control group included 30 subjects (Table 1)who were students of Chosun University. And the inclusion criteria was relatively well-balanced faces, exclusion criteria was: previous orthodontic treatment, markedly appearance of malocclusion with an unacceptable profile, missing permanent teeth other than the third molars. (Table1).

Table 1. Sample size, sex distribution and age.

| Group | Group I | Group II | Group III |
|---|---|---|---|
| Male | 15 | 11 | 17 |
| Female | 15 | 19 | 13 |
| Total | 30 | 30 | 30 |
| Average of Age | 23 Y 1 M | 22 Y 2 M | 26 Y 6 M |

For each subject a cephalometric analysis was done. The lateral cephalograms were traced and analyzed with help of a computerized Quick Ceph Program.

Landmarks are illustrated in Figure 1:

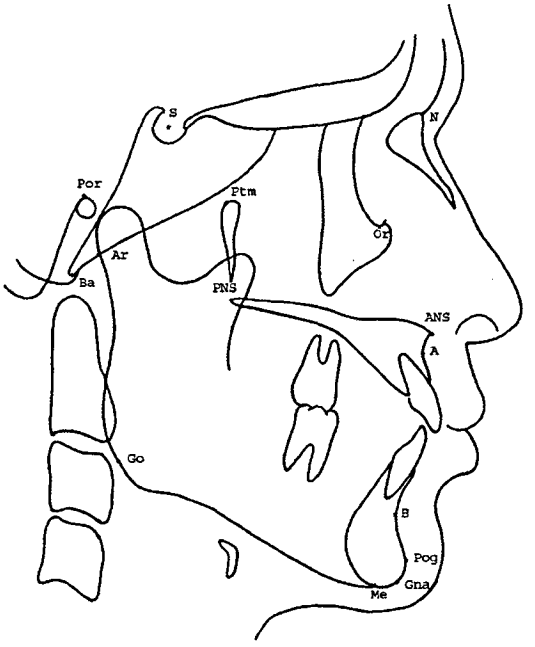


Figure 1. Reference points on the cephalometric film

S: Center of sella turcica.

Porion: Most superior point of external auditory meatus.

Basion: Most inferior point of the occipital bone.

Pt- Point (Pterygoid): Eleven clock position of the Pterygoid fissure.

Nasion: V notch of frontal and nasal bones.

Orbitale: Most inferior point of the orbital contour.

CF: The intersection of Frankfort and PTV.

ANS: Tip of the anterior nasal spine.

PNS: Tip of the posterior nasal spine.

A- Point: Deepest point between ANS, and the upper incisal alveolus.

B Point: Deepest point between Pogonion, and lower incisal alveolus.

Pogonion: Most anterior point of Symphysis.

Menton: Most inferior point on the symphyseal outline.

Articular: Intersection of inferior cranial base surface & posterior surface of condyle.

Gnathion: Cephalometric landmark formed by the intersection of the tangent to the most inferior point.

Gonion: The midpoint of the contour connecting the ramous to the body of the mandibular.

We used these planes for references: (Figure 2)

1. Sella Nasion plane: plane that lies between Sella and Nasion.
2. Frankfort Horizontal Plane: plane connects the right and left Orbitale with Porion. This plane is an approximation of how the patients hold their heads and necks.
3. Mandibular plane: The line between Gonion and Gnathion (Steiner Mandibular Plane).
4. Palatal plane: Plane that lies between ANS and PNS Plane.
5. Ba-N: The line between Basion and Nasion.

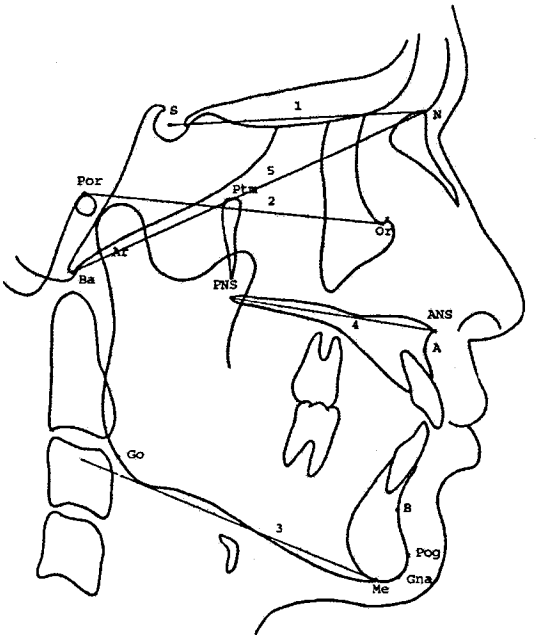


Figure 2. Reference plane on the profile cephalometric film.

For the assessment of anterior posterior skeletal growth direction: SNA (1), SNB (2), ANB (3).

For the assessment of vertical skeletal growth direction : saddle angle (4), cranial deflect (5), articular angle (6), maxillary height angle (7), SN-Palatal plane (8), palatal plane angle (9), mandibular plane (10), GoGn-SN (11), Gonial angle (12), upper Gonial angle (13), lower Gonial angle (14) (Figure 3).

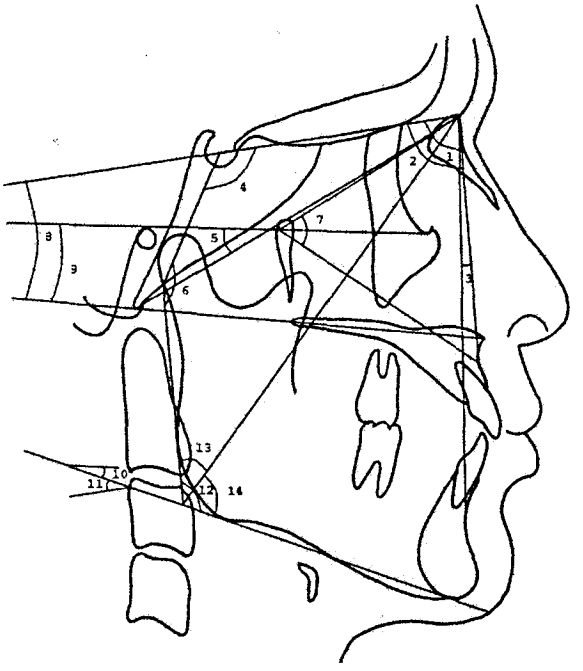


Figure 3. Angular measurements.

Table 2. The definition of cephalometric measurements used in this study:

| | |
|---|---|
| SNA | Angle determined by points S, N and A |
| SNB | Angle determined by Points S, N, and B |
| ANB | Angle formed by the intersection of lines NA, NB, which easures the anterior-posterior relation of the maxilla and the mandible |
| Cranial deflection | Angle between Nasion-Basion and Frankfort Plane |
| Saddle angle | Nasion - Sella - Ar |
| Articular angle | S-Ar-Go |
| Maxillary Height angle | Nasion - CF- A Point |
| SN-Palatal plane angle | Angle formed by the intersection of the sella nasion and the palatal plane. This established the degree of inclination of the maxilla in relation to the anterior base of the cranium. |
| Palatal plane angle | Angle formed by the intersection of Frankfort plane and palatal plane |
| Mandibular Plane angle | Angle formed by the intersection of the mandibular plane and Frankfort Plane |
| SN-GoGna angle | Angle measuring the inclination of the mandibular plane in relation to the anterior base of cranium |
| Gonial angle | Ar - Gonion - Gnathion |
| Upper Goinial angle | Ar Gonion - Nasion |
| Lower Gonial angle | Nasion Gonion Gnathion |

**DATA ANALYSIS:**

After analysis of all of subject with Rickets, Downs, Steiner, Jarabak analysis, angular measurements were obtained.

Anterior-Posterior position of three groups were also divided on the basis of the values for the SNA, SNB, ANB angle. (Table 3)

Table 3. Means and Standard deviations of groups I, II, and III

| | Group I | Group II | Group III |
|---|---|---|---|
| **SNA** | 82.9 ± 4 | 80.2 ± 2.8 | 80.1 ± 2.9 |
| **SNB** | 79.7 ± 3.3 | 73.5 ± 3.1 | 86.2 ± 3.3 |
| **ANB** | 3.4 ± 1.8 | 6.7 ± 1.6 | -6.1 ± 2.2 |

We calculated descriptive statistics for each group and investigated differences between the experimental and control groups by analysis of variance (ANOVA) with the Bonferroni post hoc test. $P < .05$ was considered as a statistically significant difference.

# Ⅲ. RESULTS

Descriptive statistics of Mean, Standard deviation and statistical comparison of group means on cephalometric values in three groups with different skeletal relationships in the sagittal plane are presented in Table 4.

Table 4. Comparison of Normal, Ⅱ and Ⅲ groups

| | Group I | | Group Ⅱ | | Group Ⅲ | | Significance | | |
|---|---|---|---|---|---|---|---|---|---|
| Variables | Mean | S.D | Mean | S.D | Mean | S.D | I vs Ⅱ | Ⅱ vs Ⅲ | I vs Ⅲ |
| Cranial deflection | 27.1 | 1.6 | 28.2 | 1.9 | 30.1 | 2.2 | NS | ** | *** |
| Saddle Angle | 125.3 | 4.2 | 125.5 | 4.7 | 124.5 | 4.7 | NS | NS | NS |
| Articular Angle | 148.9 | 5.5 | 154.8 | 6.1 | 142.5 | 5.7 | ** | *** | *** |
| Maxillary Height | 62.9 | 4.6 | 65.2 | 2.8 | 64.8 | 3.6 | NS | NS | NS |
| SN/Palatal plane | 8.7 | 3.5 | 11.2 | 2.5 | 8.6 | 3.8 | * | ** | NS |
| Palatal Plane Angle | 1.5 | 2.95 | 2.3 | 2.8 | -1 | 2.9 | NS | *** | ** |
| Mandibular Plane | 23.6 | 4.8 | 37.8 | 6.8 | 24.5 | 3.5 | *** | *** | NS |
| GoGn-SN angle | 30.8 | 5.6 | 46.7 | 6.1 | 34 | 4.2 | *** | *** | NS |
| Gonial Angle | 116.6 | 6.7 | 126.4 | 8.5 | 127.4 | 5.1 | *** | NS | *** |
| Upper Gonial Angle | 44.2 | 3.4 | 42.7 | 4.4 | 48.5 | 3.4 | NS | *** | *** |
| Lower Gonial Angle | 72.5 | 4.7 | 83.7 | 6.4 | 79.1 | 3.4 | *** | ** | *** |

NS: Non significance; * $P < .05$; ** $P < .01$; *** $P < .001$

Cranial deflection angle: The Cranial deflection angle was 27.1° in the control group. There was no significant difference between group I and group Ⅱ, but there was significant difference between group I and Ⅲ ($P < .01$), group Ⅱ and Ⅲ($P < .001$).

Saddle angle: The saddle angle was 125.3° in the group I. There were no significant differences between three groups.

Articular angle: The articular angle was 148.9° in the group I. There were significant differences between three groups ($P < .01$).

Maxillary Height angle: The Maxillary height angle was 62.9°. There was no significant difference between three groups.

SN-Palatal plane angle: The angle was 8.7° in the group I. There was no significant difference between group I and group Ⅲ. But there was significant difference between group I and Ⅱ ($P < .05$), group Ⅱ and Ⅲ ($P < .05$).

SN-GoGn angle: The SN-GoGn angle was 30.8° in the group I. There was no significant difference between group I and Ⅲ. But there was significant difference between group Ⅱ and group I, Ⅲ ($P < .001$).

Palatal Plane angle: The palatal plane angle was 1.5° in group I .There was no significant difference between group I and group Ⅱ. There was significant difference between group Ⅱ and Ⅲ, group I and group Ⅲ ($P < .01$).

Mandibular plane angle: The mandibular angle was 23.6° in the group I. There

was no significant difference between group I and Ⅲ. There was significant difference between group Ⅱ and group Ⅲ, and between group I and group Ⅱ (P < .001).

Gonial angle: The gonial angle was 116.6° in group I. There was no significant between group Ⅱ and Ⅲ. But there was significant difference between group I and Ⅱ, group I and Ⅲ (P < .001).

Upper gonial angle: The upper gonial angle was 44.2° in group I. There was no significant difference between group I and Ⅱ .But there was significant difference between group Ⅱ and Ⅲ, Group I and Ⅲ (P < .001).

Lower gonial angle: The lower gonial angle was 72.5° in the group I. There was significant difference between group I and group Ⅱ ( P < .001), group II and group Ⅲ ( P < .01), group I and group Ⅲ ( P < .001).

# Ⅳ. DISCUSSION

For the mandibular surgical advancement management of severe mandibular prognathism and retrognathism, it would aid the clinician to know the difference of vertical skeletal angular in cephalometric analysis. Angular measurements have fewer projection errors than linear measurements in comparing vertical growth component of craniofacial structure of subjects. No sex differences were assessed as subgroups since it would be too small for statistical analysis, beside with respect to vertical angular measurements, previous studies could not find differences between female and male subjects. Age is an important consideration in studies involving the cranial base. Subjects over the age of twenty would be ideal, since growth of the structures comprising the cranial base is virtually completed by the age of twenty. Pancherz[21] noted a finding of mandible retrognathia based on the angular measurements SNA, SNB, SN-Pog. In the present study, we used SNA, SNB, and ANB to evaluate the anterior-posterior jaw relationship. Tweed[4] emphasized the significance of the Frankfort mandiblualr plane angle in diagnosis. Riedel[17] studied, on a somewhat similar sample, the anatomical relationships using the plane from Nasion to Sella turcicas the principal plane of reference, instead of Frankfort horizontal.

In this study, statistical evaluation of the saddle angle did not show a significant difference among three groups. A number of studies have attempted to identify craniofacial differences between the classes of malocclusion. Malinowski[7]

suggested that the cranial base is important for increase in length and breath of the mandible and Singh et al[11] connected on the significance of cranial base in Class III malocclusion. Hopkin et al[29], using articulare to represent the posterior limit of the cranial base, described relationship between the cranial base angle and prognathism with the angle systematically reducing from class II,via class I, to class III individuals. Kerr and Hirst[30] found that the cranial base angle to be the best discriminator between Angle class I and class II cases. Kerr and Adams[31] showed a trend of reducing cranial base angle from class II toward class III malocclusion. Renfroe[32] could find no correlation between cranial base angle and Angle Class I or class II malocclusion. Dhopatkar, Bhatia, Rock[33], found that the cranial base angle alone does not appear to play a pivotal part in the establishment of malocclusion. Andria et al[34] also concluded that the saddle angle by itself does not appear to have any statically significance to the position of the chin the profile Wallis et al[37] found a longer anterior cranial base and a more obtuse cranial base angle in Class II malocclusion group. Jarabak[27], malocclusion in which maxillary base is related normally to cranial anatomy, and the mandibular base is posterior, saddle angle may vary 10 degree from the mean. Naphtali Brezniak et al[35], no statistically significant difference was found between the class II malocclusion and Class I group.

In agreement with Ricketts[28], high angle is warning of abnormal growth pattern, and associated with excessive mandibular growth (severe prognathism). In the present study we found that cranial deflection of group III is high angle.

Houston[36] theorized that in Class II malocclusion, the retrognathic position of the mandible is caused by a more posterior articulation of the condyle. Jarabak[27], small saddle angle and articular angles, may become a skeletal class III malocclusion. We found that there was significant difference of the articular angle among three groups in agreement with the previous studies, the articular angle increased in group II and decreased in group III. This angle can be an important factor in the diagnosis extreme mandibular growth.

Because of the sample of this study had normal maxillary growth, statistical evaluation of the maxillary height angle did not show a significant difference among three groups. Park et al[8], in typing of malocclusion, the most common type was found to be one which maxilla were in normal range, while mandibles were in protrusive tendency.

Palatal plane was downward at its anterior end as in group II. Jarapak[27] reported that the palatal plane is parallel or nearly so, to the Frankfort plane, as in neutroclusions and distocclusions and the palatal plane upward at its anterior end as in certain types of Class III malocclusion. Rarely there are changes in the cant of the palatal plane in the skeletal type.

The mean of GoGn-SN angle in the mandibular retrognathism was 46.7 degree, and the mandibular plane angle was obtuse. This result was not agreement with Jarabak that the GoGn-SN angle in the mandibular prognathism exceeds 40 degree, the mandibular angle is obtuse. This discordance can be attributed to the fact that sample used in this study was extreme cases with severely mandibular

prognathism and severely mandibular retrognathism.

Jensen and Palling[38], in a recent survey of the gonial angle, showed that, while this angle cannot by itself be responsible for marked facial disharmony, it may well reflect the coordination and proportion between the various parts that constitute the unity of the face.

Renfroe[32] described a more acute gonial angle in Class Ⅱ groups as compared with a normal group. Godiawala et al[25] did not find statistically significant differences in the gonial angle between Class Ⅱ malocclusion and Class I malocclusion.

Jarabak[27], large gonion angal may become a skeletal class Ⅲ malocclusion. He found that the gonion can and does grow posteriorly in mandibles where the upper half of the gonial angle is low

Park et al[8], Class Ⅲ malocclusion were also classified based on SNA, SNB angle in normal range. In Class Ⅲ malocclusion, mandible inclination, lower angle were appeared to be greater. But in this study, the gonial angle increased in group Ⅱ and Ⅲ. There was significant difference of the lower gonial angle among three groups. Once again, this was due to the fact that the individuals in the present study were extreme mandibular growth.

In this study, the major outcome of the statistical comparison among groups of subjects with skeletal class I, class Ⅱ, class Ⅲ consisted of significant differences for the values of articular angle and lower gonial angle. In particular, both of these measurements are significantly greater in subjects with Class Ⅱ skeletal

disharmony than in subjects with skeletal class Ⅲ. It should be also emphasized that the three groups of subjects, selected according to different skeletal relationships in the sagittal plane (Group Ⅰ, Ⅱ, and Ⅲ), did not show any significant differences as to saddle angle and maxillary height angle.

# V. CONCLUSION

To find out the role of vertical angle components in the change of mandibular abnormal growth, we evaluated the vertical angular differences among three groups: normal, severly retrognathic mandible and severely prognathic mandible. The findings were as follow :

1) The results indicate that many differences exist between the normal group and the severely retrognathic mandible group: articular angle, SN-Paltal plane angle, Mandibular angle, GoGna-SN angle, Gonial angle were large in the retronathic mandible group.
2) Compared to the normal group, severely prognathic mandible group had differences as follow: Cranial deflection angle, gonial angle, upper gonial angle were larger. Palatal plane angle and articular angle were smaller.
3) Three groups of subjects did not show any significant differences in saddle angle and maxillary height angle.
4) There were significant differences among three groups in articular angle and lower gonial angle.

Finally, it was concluded that the articular angle and the lower gonial angle played an important role in skeletal mandibular excess and mandibular deficient patients but the saddle angle and the maxillary height angle did not.

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