Description of the Mandibular Growth Rotation Pattern and Golden Proportion in the Lower Facial Third Region

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Abstract

Background: Facial aesthetic has long been an important area for orthodontists. In orthodontics, the main consideration is directed towards potentials to produce malocclusion corrections that affect facial changes and this is in line with the main motivation of patients in general to undergo orthodontic treatment. In this connection, the lower third of the face is important, considering the main impact of orthodontic treatment is on that area. In this area, known proportions are believed to be related to a harmonious profile, the golden proportion is one of that. On the other hand, we also know the rotation of the mandibular growth associated with protrusive or retrusive facial patterns and the rotation of the mandibular growth is thought to be related to dimensions in the lower third of the face.

Objective: This study was conducted to describe the rotation pattern of mandibular growth and golden proportion in the lower third of the face.

Materials and Methods: Measurements and calculations performed on fifty-two (52) lateral cephalograms of subjects from the Deutromalay sub-race that had an attractive face according to laypeople's judgment. The rotation pattern of the growth of mandible is seen through the tendency of the facial growth pattern which may be hyperdivergen or hypodivergen and produce a mandibular rotation pattern downward and backward or forward. While the golden ratio is measured in the lower third of the face by comparing the distance from subnasale to stomion and stomion to gnathion.

Results: The study showed that most subjects had vertical (hyperdivergen) mandibular growth tendency which is in harmonious with rotation patterns clockwise or downwards and backwards and only several subjects had the exact golden proportion of 0.61:1.

Conclusion: The existing golden proportion may not be in accordance with the ethnic or racial variations of the subjects of this study.

Keywords: Mandibular Rotation Pattern; Golden Proportion; Lower Third Face Height

Introduction

In orthodontic treatment, facial aesthetics are an important part of the consideration related to diagnosis and treatment plans, because the desire to get a better facial aesthetic is generally the main factor that motivates patients to undergo orthodontic treatment [1,2]. Therefore, treatments carried out for correcting a malocclusion will be directed to efforts that have a real impact on changes in facial aesthetics [3,4]. Area of the face that is particularly important for orthodontists is the lower third region, which covers the subnasale to gnathion or menton (Figure 1) and the ratio that is believed to be associated with a harmonious outline profile between maxillary alveolar height (subnasale to stomion) to mandibular face height (stomion to gnathion is 0.62:1) [5,6].
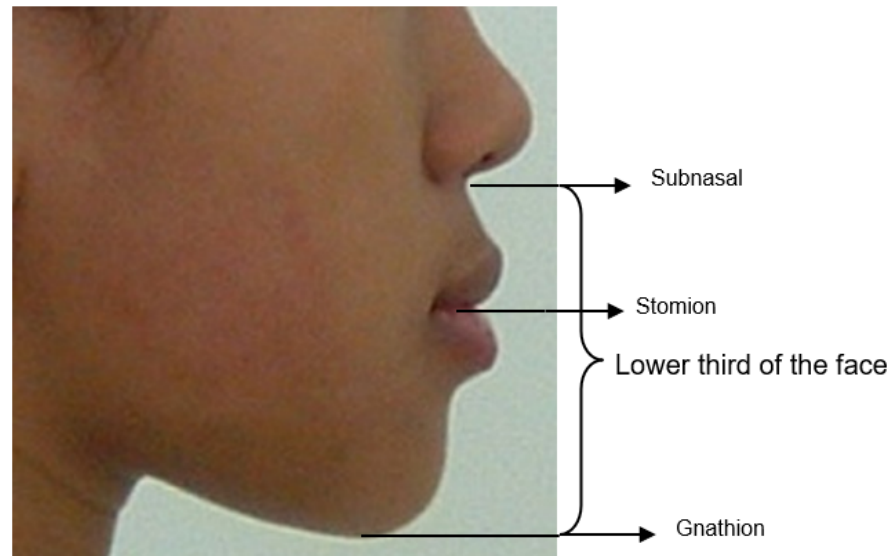
Figure 1: *The lower third of the face starts from the subnasale under the nose to the menton in the chin.*

In relation to facial aesthetics, we also recognize the pattern of mandibular growth rotation which is distinguished into clockwise rotation and counterclockwise rotation. According to Down's cephalometric analysis, the direction of mandibular growth can be predicted by measuring the Y (growth) axis. In this measurement we can get an angle with a larger value or an angle with a smaller value. Smaller values tend to be found in class III malocclusions and larger values tend to be found in class II malocclusions [6]. Information obtained through this Y-axis measurement shows the extent or amount of rotation downward and backward (clockwise) or forward (counterclockwise) of the chin in relation to the upper face. In this connection, the measurement results which tend to be smaller will indicate the pattern of growth of the mandible in the horizontal direction is greater than in the vertical direction. Vice versa, the results of measurements that tend to be larger will indicate that the pattern of growth of the mandible in the vertical direction is greater than in the horizontal direction. Moving on from these considerations, it can be assumed that the tendency of growth patterns in the horizontal and vertical directions will affect the results of the measurement of the mandibular plane angle [6]. While the tendency of growth patterns in both vertical and horizontal directions may affect the dimensions of the lower third of the face.

This research was conducted to describe the rotation pattern and growth direction of the mandible and golden ratio in the lower third of the face on different subjects. Measurements made are expected to show the extent to which the conditions found in this study are in harmony with the existing golden ratio concept.

Materials and Methods

The subject of this research is the Deutromalay sub-race individuals which has been considered attractive by lay people and has never undergone orthodontic treatment and is willing to follow established research protocols which include the production of lateral cephalograms. Fifty-two (52) lateral cephalograms were successfully collected to undergo measurement of the mandible plane angle and the golden ratio in the lower facial third region. Measurement of mandibular plane angle is performed according to the Down method using the Frakfort horizontal as reference plane connected to the mandibular plane. The Frankfort horizontal plane is obtained by connecting the most superior point of the porion with the most inferior point of the orbit [7] while the mandibular plane is obtained by connecting

menton, the most inferior point of the chin, and gonion in the angle of the mandible. The average value of this angle according to Down is 21.9^0 [6].

Golden ratio calculation is done by first tracing the soft tissue part of the lateral cephalogram of each subject. Then the anatomical landmarks were identified, such as subnasale, stomion and gnation (Figure 1). The concept of golden ratio in the lower third of the face requires a value of 0.61: 1 for the distance from the subnasale to the stomion and the distance from the stomion to the gnathion. This golden ratio is related to the basic principle of facial harmony and covers the upper face height or the middle third of the face as well. So, in a harmonious profile, the golden ratio at the upper face height to the maxillary alveolar height (distance from subnasale to stomion) and to the mandibular face height (distance from stomion to gnathion) is 1: 0.61: 1 [6].

Results

The results of measurements made on the subject of this study are mandibular plane angle and golden ratio on the lower third of the face. Measurements were made on each tracing of the lateral cephalogram of the subjects as shown in table 1. The values obtained show the magnitude of variation compared to the normal value, both for the mandibular plane angle and the golden ratio of the subjects. Based on the tendency of growth direction of the mandible, then almost all subjects (47) have a tendency towards vertical growth compared with a small proportion of subjects (5) who show the tendency towards horizontal growth of the mandible (Table 2). Based on the golden ratio value, the subject of this study also showed considerable variation compared to the standard golden ratio. Measurement results that refer to the golden ratio standard value show that only a small proportion of subjects (9) have a value of equal to or slightly more than standard value of the golden ratio while more than half of subjects in this study (43) show variations in values below/smaller than the standard value of the golden ratio (Table 3).

No	mpa	gr	No	mpa	gr
1	36	0,49 : 1	27	19	0,43 : 1
2	19	0,48 : 1	28	33	0,46 : 1
3	46	0,49 : 1	29	31	0,47 : 1
4	27	0,32 : 1	30	20	0,48 : 1
5	28	0,52 : 1	31	33	0,48 : 1
6	25	0,43 : 1	32	29	0,47 : 1
7	30	0,44 : 1	33	46	0,43 : 1
8	33	0,70 : 1	34	37	0,61 : 1
9	22	0,53 : 1	35	36	0,44 : 1
10	22	0,47 : 1	36	25	0,52 : 1
11	29	0,52 : 1	37	23	0,48 : 1
12	27	0,53 : 1	38	34	0,62 : 1
13	19	0,50 : 1	39	23	0,54 : 1
14	46	0,61 : 1	40	34	0,53 : 1
15	32	0,53 : 1	41	35	0,43 : 1
16	24	0,53 : 1	42	38	0,61 : 1
17	27	0,45 : 1	43	29	0,39 : 1
18	24	0,44 : 1	44	22	0,49 : 1
19	33	0,62 : 1	45	32	0,61 : 1
20	19	0,49 : 1	46	28	0,47 : 1
21	21	0,61 : 1	47	33	0,51 : 1
22	32	0,49 : 1	48	26	0,48 : 1
23	32	0,48 : 1	49	27	0,46 : 1
24	24	0,51 : 1	50	40	0,61 : 1
25	28	0,43 : 1	51	24	0,54 : 1
26	37	0,50 : 1	52	28	0,44 : 1

Table 1: *Mandibular plane angle (mpa) and golden ratio (gr).*

mpa	∑ subject	Facial pattern - mandibular growth tendency	Percentage
$\geq 21,9^0$	47	Hyperdivergen - vertical growth tendency	90,4%
$\leq 21,9^0$	5	hypodivergen - horizontal growth tendency	9,6%

***Table 2:** Percentage of subjects based on mandibular growth tendency (mpa).*

Golden ratio	∑ subject	Percentage
$\geq 0,61$	9	17,3%
$\leq 0,61$	43	82,7%

***Table 3:** Percentage of subjects based on golden ratio.*

The value of the mandibular plane angle in the subjects of this study ranged from the smallest is 19^0 (three subjects) and the largest is 46^0, which is also to three subjects. While, for the golden ratio, the values obtained ranged from 0.32: 1 in one subject to 0.70: 1 which was also in only one subject (Table 1).

Based on the number of subjects, there are five that have a mandibular plane angle value of 33^0, then several groups of four subjects each having a mandibular plane angle of 19^0, 24^0, 27^0, 28^0 and 32^0. Several groups of three subjects each have a mandibular plane angle of 22^0, 29^0 and 46^0. Several groups of two subjects each have a mandibular plane angle of 23^0, 25^0, 34^0, 36^0 and 37^0. Finally, there are also several one subject groups that have a mandibular plane angle of 20^0, 21^0, 26^0, 30^0, 31^0, 35^0, 35^0, 38^0 and 40^0 (Table 4). Table 5 shows the distribution of subjects based on golden ratio calculation in this study. It is clear here that, subjects who have a value in exact harmony with the golden ratio concept are six (6). The same number of subjects also appeared to have a golden ratio value of 0.48: 1. Furthermore, there are three groups of five (5) subjects which have golden ratio values of 0.43: 1, 0.49: 1, and 0.53: 1 (Table 5). Golden ratio values of 0.44: 1 and 0.47: 1 were obtained by each of the four (4) subjects groups. A golden ratio value of 0.52: 1 was found in three (3) subjects groups. Furthermore, there are each of 2 subjects groups for golden ratio values of 0.46: 1, 0.50: 1, 0.51: 1, 0.54: 1 and 0.62: 1. Variations in other golden ratio values, namely 0, 32: 1, 0.39: 1 and 0.45: 1, obtained each in one (1) subject (Table 5), respectively.

	Variation of mandibular plane angle values (degree)																				
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	40	46
∑ subject	4	1	1	3	2	4	2	1	4	4	3	1	1	4	5	2	1	2	2	1	1	3

***Table 4:** Distribution of subjects based on mandibular plane angle variations.*

	Variation of golden ratio values																
	0,32:1	0,39:1	0,43:1	0,44:1	0,45:1	0,46:1	0,47:1	0,48:1	0,49:1	0,50:1	0,51:1	0,52;1	0,53:1	0,54:1	0,61:1	0,62:1	0,70:1
∑ subject	1	1	5	4	1	2	4	6	5	2	2	3	5	2	6	2	1

***Table 5:** Distribution of subjects based on golden ratio variation.*

Discussion

Aesthetics is still the main goal in orthodontics, because the desire to change their appearance is still the most reason for people's decision to undergo orthodontic treatment. Starting from this fact, every aspect related to the concept of facial aesthetics becomes important for orthodontists [8-11]. However, advances in technology and modern civilization today have given birth to the appearance and understanding of different facial aesthetic concepts.

It is undeniable that today it is becoming increasingly clear that tangible variations of facial patterns and harmonious aesthetic profiles do exist between individuals of different ethnic and racial backgrounds. A number of research reports related to this problem are also increasing and are easily found in the literature. In the field of orthodontics, research is generally carried out

through various methods including radiology, photography, clinical methods and various other ways in harmony with the latest technological developments [1]. This research was conducted by taking several measurements through radiology, namely the lateral cephalogram.

The measurement results obtained show considerable variation compared to the existing standard values, both for the measurement of the mandibular plane angle and the calculation of the golden ratio. Some subjects who had values according to the golden ratio standard, which was 0.61: 1, were proven to have different mandibular plane angle values compared to the mean value according to the Down method, which was 21.9^0. The mandibular plane angle of these subjects are 21^0, 32^0, 33^0, 37^0, 38^0 and 40^0 respectively (Table 1). Some subjects who have golden ratios according to their standard values appear to have five (5) variation in the value of the mandibular plane angle. In five variations of these values, four of them have mandibular plane angle above the mean value of the angle according to Down and one (1) subject has the value of the mandibular plane angle below the standard value of the Down method. When four subjects with mandibular plane angle values greater than the standard value are understood as individuals with hyperdivergent facial patterns that have a tendency for the mandibular growth pattern in the vertical direction and means that they also have a mandibular growth tendency to rotate downward and backward (clockwise) then one subjects who have a mandibular plane angle value smaller than the standard value will be understood as individuals with hypodivergent facial patterns that have a tendency for the mandibular growth pattern in the horizontal direction and hence also the forward (counterclockwise) rotation of the mandibular growth tendency. Thus, the concept of a harmonious face with a golden ratio in the lower third of the face can be found in individuals with hyperdivergen or hypodivergen facial patterns. This also shows that the golden ratio is not related to the direction of rotation patern of the mandible growth.

The informations obtained in this study also indicate that the existing golden ratio standard values may not be suitable for different ethnic or racial variations. Efforts to find a golden ratio value that is specific to a particular ethnic or race should be considered given that in this technological era that is without space and time restrictions, various informations is more easily accessible including information about the aesthetic concept of the face in the field of orthodontics. Ordinary people have found it easier to access and interpret existing information with different perceptions. Therefore, the availability of specific aesthetic parameter values according to ethnicity and race will certainly be better and more beneficial for us all.

Conclusion

The golden ratio value obtained in this study shows a large variation compared to the existing standard of golden ratio value (0.61: 1). In this study, out of the fifty two subjects there are only a small number (6) subjects that are in harmony with the existing standard of golden ratio value. Likewise, the value of the mandibular plane angle informs the tendency of the subject's facial pattern which at the same time shows the tendency of the subject's rotational growth pattern of the mandible. In this regard, most subjects (47) have hyperdivergen facial patterns with a tendency for the growth/rotation pattern of the mandible in the vertical direction. The rest (5 subjects) showed hypodivergen facial patterns and were therefore considered to have a tendency for the growth/rotation pattern of the mandible in the horizontal direction.

Further research is needed to find a golden ratio value that is specific to a particular ethnic or race to be used as a reference value in the aesthetic concepts related to orthodontic treatment.

Clarification

The researcher does not have a conflict of interest with any party related to the material in this study.

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