**Original Research Article**

# Assessment of facial golden proportions in Gujarati population – A retrospective study

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**ABSTRACT**

**Introduction:** The face excels in beauty when compared with other anatomical divisions of the human beings" - Leonardo da Vinci. Golden Proportion is the mathematical ratio which has special properties, most aesthetically pleasing and aesthetic harmony.

**Materials and Methods:** The study sample consisted of 85 subjects. The subjects were randomly selected from the outpatient department. The collected sample age ranges from 18 to 25 years. The subjects with developmental anomalies and history of any trauma were not included. Only the Population that belongs to Gujarat are included to meet the aim of the study to analyse the population.

**Results:** The mean of all study parameters were in the range of 1.301 to 1.423. The p values for all parameters except TS-TS/LC-LC for class 2 skeletal pattern is 0.001 which shows that they all have significant relation to the ideal proportions.

**Conclusion:** It is concluded from the study that the population of Gujarat do not follow ideal/Golden proportion.

## 1. Introduction

What we today call normal occlusion was described as early as the eighteenth century by John Hunter.[1] The Golden Proportion "phi" as said by American mathematician Mark Barr is 1.618.[2] In a comprehensive article on aesthetics written in 1973, Lombardi "' mentioned the golden proportion and anticipated more detailed observations regarding its application to dental esthetics.[2]

Throughout the history, this ratio is considered the most pleasing to the eye. The visual stimuli pass to the centre of vision in the brain where the physiological stimuli can endanger a pleasant or unpleasant psychological response and this ratio give the most pleasing stimuli.[2] Beauty is the phenomenon of experiencing pleasure, through the perception of balance.[3] The face excels in beauty when compared with other anatomical divisions of the human beings" - Leonardo da Vinci.[4]

The Golden Section – A precise way of dividing a line, music or anything goes back to 500BC, when Pythagoras proved that the Golden Section was the basis for the proportions of human figure and that the human body was built with each part with a definite golden proportion.[4] This ratio can be related to human body by several means like the length of first figure joint to the ratio of the next two joints is similar to the ratio of two finger joint to the length of whole finger. The head even when viewed from side illustrates Golden Proportion.[4]

This mathematical ratio with special properties, most aesthetically pleasing and aesthetic harmonious but the deviation from which results into health problems like risk of respiratory, jaw and maxillofacial disorders. Corrective procedures that result the face to its ideal will improve health problem.[5,6]

In the year 1982, Ricketts has been the first Orthodontist to apply it to the composition of facial hard and soft tissues.[7,8] The Golden Divider is an instrument used in morphological analysis of teeth, skeleton, and soft tissues of the face.[8]

Discrepancies in bone development in the facial thirds may be considered aesthetically unpleasing, and individuals with short or long faces present the risk of developing different types of disorders, which are frequently associated with cases of malocclusion class II and III. The divine proportion is still employed in orthodontic-orthognathic planning and used as a guideline for the treatment to improve the facial aesthetic balance and to correct biting.[9]

The Golden ratio is considered as a universal facial aesthetical standard.[7,10,11] The Greek philosophers admired nature's beauty and its unique balance, realizing that there is divinity in every creation of nature; each natural beauty was in proportion. They discovered Divinity in this natural proportion and coined it as "Divine Proportion."[10] They have used it extensively in Greek architecture.[12]

It is researcher's opinion that deviation from the golden ratio can result in development of facial abnormalities.[10] Thomas Jefferson a well-known architect stated that deviation of from Golden proportion can result in the development of facial abnormalities and disorders. The aesthetical standards are both advantageous and disadvantageous but must be tailored based on application.[10]

As said by Euclid, "A straight line is said to have been cut in extreme and mean ratio when, as the whole line is to the greater segment, so is the greater to the lesser." When a line is divided into two unequal segments by a point (phi), the ratio of smaller segment to the larger segment is equal to the ratio of larger segment to the line.[10]

This appears to the human dentition as well, the maxillary anterior teeth follow the rule of Golden Proportion when viewed from front, the width lateral incisor is to the width of central incisor and the width of canine is to the width lateral incisor, the smaller tooth is 62% the size of larger tooth.

Malocclusion can be skeletal or dental, dental malocclusion is the mal relation of the teeth and skeletal is when there is defect in the maxillary and/or mandibular development leaving a huge impact on the positioning, alignment, and health of oral structures. Skeletal class 1 malocclusion is when the long axis of mandibular incisors passes through the long axis of crown of maxillary incisors. In skeletal class 2, the long axis of mandibular incisors lies palatal to the long axis of the crown of maxillary incisors. The long axis of mandibular incisors lies labially in terms of skeletal class 3 relation. The mean value of ANB angle is 2 degrees and an increased angle means class 2 skeletal relation and the decreased or negative value means skeletal class 3 relation.

This study aims to identify and establish the facial proportions in the young adults of Gujarat with different groups of malocclusion and skeletal pattern and to make a comparison with the Golden Proportion. The study objectives are to find skeletal and growth pattern and along with this find the ratios frontal facial parameters and to compare facial proportions with the skeletal and growth patterns.

## 2. Materials and Methods

This cross-sectional study was approved by the Institutional Review Board. The Study got conducted in the Research Lab of Department of Orthodontics & Dentofacial Orthopaedics.

### 2.1. Inclusion criteria

1. Full set of complete permanent dentition up to 2nd molar.
2. Age criteria: Young Adults (18 – 25 years of age).

### 2.2. Exclusion criteria

1. History of orthodontic treatment.
2. History of trauma to anterior teeth.
3. Any developmental anomalies.
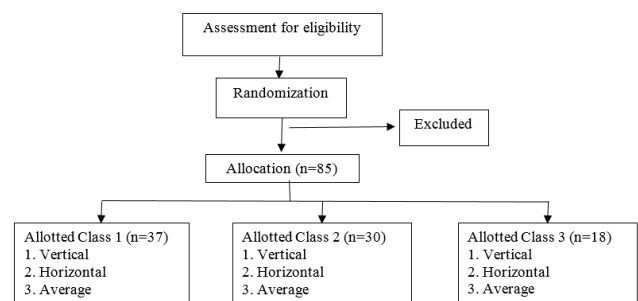


**Figure 1:** According to CONSORT guidelines (Consolidated Standards of Reporting Trials)

### 2.3. Subjects

The study sample consisted of the Pre – treatment Lateral Cephalogram X rays and Pre – treatment Frontal Repose Photograph of 85 subjects. The subjects were randomly selected from the outpatient department. The radiographs were all taken by the Kodiak CS 8000C Carestream and the photographs were taken by Canon 1500D Camera. The subjects had 31 males and 54 females. The collected sample age ranges from 18 to 25 years. The subjects with developmental anomalies and history of any trauma were not included. Only the Population that belongs to Gujarat are included to meet the aim of the study to analyse the population. There is no ethical interference as the study does

not involve patient directly, but it uses the available data from the Orthodontics Department.

For tracing purpose, cellulose acetate sheets were used along with 0.7 mm (about 0.03 in) lead pencil. A protractor and a plastic roll-n-draw scale were used to measure the lines and angles. A single operator performed the tracings in a standardized manner to avoid errors due to intra- operation variations.Figure 2



**Figure 2:**

For each Cephalometric tracing obtained the parameters Sella (S) the centre of Sella turcica, Nasion (N) the anterior most point of the frontonasal suture seen on lateral cephalogram, point A the most deepest bony landmark between the anterior nasal spine and the incisor teeth, point B the most deepest point in between the mandibular incisor and the bony chin, Gonion (Go) the tangent point on the angle of mandible and Gnathion (Gn) lowest and most anterior midline point on the mandibular symphysis were marked manually by a single person.

The SNA angle, SNB angle, ANB angle and the Mandibular Plane Angle (SN plane to Go-Gn) are measured for each subject using a protractor and scale by keeping it on the viewer with the references marked. This were measured using the omega transparent ruler. Table 1

For each Frontal Repose Photographic Tracing, 5 parameters were marked Trichion (Tr) midline point on the hairline, Menton (Me) inferior most point on soft tissue chin, Zygoma (Zy) widest point in the region of zygomatic bone in the frontal view, Lateral canthus (Lc) lateral corner of the eye and Temporal Soft tissue (Ts) widest soft tissue part in the region of frontal bone.

The parameters of Facial Height (Tr – Me), Bizygomatic width or Facial width (Zy – Zy), Lateral canthus on right to

**Table 1:** The hard tissue landmarks

| 1. | **Sella (S)** | The center of the sell turcica |
|---|---|---|
| 2. | **Nasion (N)** | The most anterior point of the frontonasal suture |
| 3. | **Point A(A)** | The innermost point on the contour of the maxilla between the anterior nasal spine and the incisors |
| 4. | **Point B(B)** | The inner most point on the contour of the mandible between the incisor and the bony chin |
| 5. | **Gonion (Go)** | The point on the curvature of the angle of the mandible located by bisecting the angle formed by the line's tangent to the posterior ramus and the inferior border of the mandible |
| 6. | **Gnathion (Gn)** | The lowest, most anterior midline point on the symphysis of the mandible (midway between the Menton and pogonion) |

Lateral canthus on left (Lc – Lc) and Temporal soft tissue on right to Temporal soft tissue on left (Ts – Ts) were measured.

Further based on the ANB angle the divisions were made into skeletal Class 1, Class 2 and Class 3. The growth pattern based on the Mandibular plane angle (SN plane to Go-Gn) was decided into Horizontal, Vertical or Average pattern. The Proportion of Facial Height to Facial width and Lc – Lc to Ts – Ts were analysed and compared to the Divine Proportion.Table 2

**Table 2:** The soft tissue landmarks

| 1. | Trichion (tr) | It is the point on the hairline in the midline of the forehead |
|---|---|---|
| 2. | Menton (Me) | The most inferior point on the soft tissue chin. |
| 3. | Zygoma (Zy) | The widest point in the region of zygomatic bone seen in the frontal view. |
| 4. | Lateral canthus (Lc) | The lateral corner of the eye |
| 5. | Temporal soft tissue (Ts) | The widest soft tissue points over the temporal bone seen in frontal view |

### 2.4. Statistical analysis

The statistical analysis was performed using SPSS 20.0 software. The results were presented using mean and standard deviation. Independent t test was done to test the difference. Values less than 0.05 were considered significant and those above 0.05 were considered not significant.

## 3. Results

Table 3 shows that the mean value was 1.423 being the closest to 1.618, rest all values were in the range of 1.301 - 1.376. The highest deviation was seen for TR-ME/Bi-Z of class 3 individuals and least standard deviation was found in TS-TS/LC-LC of class 3 individuals.

As per Table 4, the difference of mean for class 2 and class 3 in comparison to class 1 was –0.007 and –0.018. The mean difference of class 1 and 3 when compared to class 2 is 0.007 and –0.011. The mean differences of class 1 and class 2 when compared to class 3 were 0.018 and 0.011.

As per Table 5, the mean difference for class 2 and class 3 in comparison to class 1 is 0.010 and -0.047 respectively and the values for class 3 show significance with golden proportion. The mean difference for class 1 and class 3 in comparison to class 2 were –0.010 and –0.057 respectively and the one for class 3 has significance with golden proportion. The mean difference for class 1 and class 2 in comparison to class 3 were 0.047 and 0.057 respectively and both show significance with golden proportion.

From Table 6, on comparison of the ratio to Golden Proportion, shows that the p values of 0.001 for TR-ME/Bi-Z parameter for all the three skeletal pattern groups. All the three classes show significance with golden proportion.

Table 7 shows the p value of TS-TS/LC-LC for class 1 and class 3 as 0.001 and for class 2 it shows value of 0.0928 when the obtained ratios were compared to the Golden Proportion. The values for class 1 and class 3 show significance with golden proportion.

**Table 3:** Mean ± SD of TR-ME/Bi-Z and TS-TS/LC-LC

| Type of Malocclusion | TR-ME/Bi-Z (Mean ± SD) | TS-TS/LC-LC (Mean ± SD) |
|---|---|---|
| Class 1(n=37) | 1.301±0.088 | 1.376±0.086 |
| Class 2(n=30) | 1.308±0.085 | 1.366±0.794 |
| Class 3(n=18) | 1.319±0.092 | 1.423±0.066 |

**Table 4:** Mean differences of TR-ME/Bi-Z

| Type of Malocclusion | Class 1 | Class 2 | Class 3 |
|---|---|---|---|
| Class 1 | - | -0.007$ | -0.018$ |
| Class 2 | 0.007$ | - | -0.011$ |
| Class 3 | 0.018$ | 0.011$ | - |

$: P value >0.05

**Table 5:** Mean Differences of TS-TS/LC-LC

| Type of Malocclusion | Class 1 | Class 2 | Class 3 |
|---|---|---|---|
| Class 1 | - | 0.010$ | -0.047* |
| Class 2 | -0.010$ | - | -0.057* |
| Class 3 | 0.047* | 0.057* | - |

*: P value <0.05

**Table 6:** Comparison of TR-ME/Bi-Z with Golden Proportion

| Type of Malocclusion | TR-ME/Bi-Z (Mean ± SD) | Golden Proportion(1.618) (p value) |
|---|---|---|
| Class 1(n=37) | 1.301±0.088 | <0.001 |
| Class 2(n=30) | 1.308±0.085 | <0.001 |
| Class 3(n=18) | 1.319±0.092 | <0.001 |

**Table 7:** Comparison of TS-TS/LC-LC with Golden Proportion

| Type of Malocclusion | TS-TS/LC-LC (Mean ± SD) | Golden Proportion(1.618) (p value) |
|---|---|---|
| Class 1(n=37) | 1.376±0.086 | <0.001 |
| Class 2(n=30) | 1.366±0.794 | 0.0928 |
| Class 3(n=18) | 1.423±0.066 | <0.001 |

## 4. Discussion

Concept of facial aesthetics and beauty started its origination along with the evolution of human beings. Sir Martin Ohm was the first one to use the term golden to describe this ratio. The Greek Philosophers admired natures beauty and divinity in each and every creation of nature. They were the one to coin it as Divine Proportion. The Golden Proportion is found in many cephalometric measurements and also in several stages of growth.[13–16]

In the present study golden proportion was applied to the population of Gujarat to assess them for golden proportion keeping in mind that face is the most expressive part of human body that is responsible for visual evaluation. Rathore Saurabh et al.[8] in their study of 200 individuals of central India concluded that there is significant difference in proportions of Indian population and the ideal ratio.

Furthermore, he stated that some parameters of facial proportions showed significant difference between Indian, Japanese, and Caucasian populations. Although there was deviation from the ideal, there was no considerable difference between males and females. Females were more near and males were more deviated from the ideal ratios. In this presented study, the mean of all the parameters came in the range of 1.301 to 1.423 and they all show a significant standard deviation from the ideal. Based on the t test, the p values of all classes for TR-ME/Bi-Z was less than 0.001 and those for class 1 and class 3 for TS-TS/LC-LC were less than 0.001 as well except class 2 that showed p value of 0.0928 which did not show any significance.

The obtained results show that the population of Gujarat does not follow Golden Proportion. The study parameters do show significance with the ideal ratios but none follow the exact golden proportion. As the natural occurrence of golden proportion is found very rarely as it is only found in models e.g., Amber Heard, Bella Hadid or esthetical paintings e.g. The painting of Monalisa. As the importance of aesthetics is taking the troll, the importance of soft tissue and its appearance is considered more than the skeletal

counterpart.

As per Saraswathi,[4] the ratios of facial height to facial width were in range of 1.16 to 1.98 for women and 1.04 to 1.97 for men, for this study the mean was 1.301 to 1.319 for this proportion. The results of this study may not represent the whole Gujarati Population due to the relatively small sample size.

## 5. Conclusion

1. There is always discrepancy in the golden proportion ratio in the assessed parameters in different kinds of skeletal malocclusion.
2. It is statistically significant difference on inter group comparison of skeletal malocclusion class 1 for all growth patterns.
3. For class 2 and class 3 only horizontal and average growth pattern show statistically significant difference.

## 6. Conflict of Interest

None.

## 7. Source of Funding

None.

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