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Evaluation of the Prevalence of Golden Percentage Among Dental Students Using a Digital Smile Design Approach

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Abstract: ***Background**: Smile esthetics plays a significant role in facial attractiveness and social confidence. Various mathematical concepts have been proposed to establish ideal anterior dental proportions, among which Snow's golden percentage remains one of the most discussed concepts in esthetic dentistry. According to this theory, the visible widths of maxillary anterior teeth should follow a fixed percentage distribution to achieve an ideal smile. However, the applicability of this concept among different populations remains controversial. **Aim**: To evaluate the prevalence of Snow's golden percentage among dental students with esthetically pleasing smiles using a digital smile design approach. **Materials and Methods**: The present observational cross-sectional study included 25 dental students of KVG Dental college and Hospital, Dakshina Kannada aged between 18 and 25 years with esthetically pleasing smiles. Subjects with missing teeth, carious lesions, crowding, spacing, restorations, or previous orthodontic treatment were excluded. Intraoral scanning of the maxillary arch was performed to obtain digital models. The apparent mesiodistal widths of maxillary anterior teeth were measured using MeshLab software. The percentage contribution of each anterior tooth relative to the total width of the six anterior teeth was calculated and compared with Snow's proposed golden percentage values. Descriptive statistical analysis including mean and standard deviation was performed. **Results**: The mean percentage values for the right maxillary canine, lateral incisor, and central incisor were 8.164%, 14.314%, and 18.108%, respectively. On the left side, the mean percentage values for the central incisor, lateral incisor, and canine were 18.612%, 14.796%, and 8.34%, respectively. None of the evaluated subjects demonstrated the exact golden percentage proportions proposed by Snow. **Conclusion**: The present study demonstrated that Snow's golden percentage was not consistently observed among dental students with esthetically pleasing smiles. These findings suggest that smile esthetics may not be solely dependent on strict mathematical proportions and highlight the importance of individualized smile design.*

Keywords: Golden percentage, smile esthetics, digital smile design, anterior tooth proportion, intraoral scanning, MeshLab

1. Introduction

Facial appearance has a profound influence on an individual's self-confidence, personality, and social interactions.[1] Among the various facial components, the smile is considered one of the most important determinants of facial attractiveness.[2] A pleasant smile enhances overall facial harmony and contributes significantly to psychological and social well-being.[3] Consequently, smile esthetics has become an important area of focus in restorative and esthetic dentistry.[4]

Smile esthetics depends on the harmonious interaction of various components including lips, gingiva, teeth, and facial structures.[5] The size, shape, alignment, color, and proportion of the anterior teeth play a major role in determining smile attractiveness.[6] Achieving ideal anterior tooth proportions has therefore become an important objective during esthetic dental treatment planning.[7]

Over the years, several mathematical and geometric theories have been proposed to define ideal dental proportions.[8] One of the earliest concepts was the golden proportion introduced by Levin.[1] The golden proportion, approximately equal to 1.618:1, has historically been associated with beauty and harmony in nature, art, and architecture.[1] In dentistry, Levin proposed that the visible width of each anterior tooth should be in a constant proportional relationship with the adjacent tooth when viewed from the frontal aspect.[1]

Although the golden proportion gained popularity in esthetic dentistry, several researchers observed that naturally attractive smiles often failed to exhibit exact golden proportion values.[5,8] Due to these limitations, Snow introduced the concept of golden percentage.[2] According to Snow's theory, each maxillary central incisor should occupy 25% of the total visible width of the six anterior teeth, each lateral incisor should occupy 15%, and each canine should occupy 10% when viewed from the frontal aspect.[2]

The golden percentage concept was considered more practical and clinically applicable because it evaluated the apparent widths of anterior teeth relative to the total anterior dental display rather than using ratios between adjacent teeth.[2] The theory aimed to provide clinicians with a simple guideline for designing esthetic smiles.[4]

However, the universal applicability of golden percentage remains controversial.[7,8] Several studies conducted among different ethnic populations have demonstrated variations in anterior tooth proportions.[9,10] Researchers have reported that naturally esthetic smiles may not necessarily conform to strict mathematical formulas.[7] Variations in facial morphology, ethnicity, genetics, and individual perception of beauty may influence smile esthetics.[11]

Modern advancements in digital dentistry have revolutionized smile analysis and esthetic treatment planning.[12] Digital smile design allows objective evaluation of dental proportions with greater precision and reproducibility compared to conventional methods.[12,13] Intraoral scanners and digital analysis software have improved the accuracy of tooth measurements while minimizing operator error.[13]

MeshLab is an open-source software widely used for three-dimensional mesh processing and digital measurements. The software enables accurate analysis of digital dental models

and provides reliable evaluation of tooth dimensions. The use of digital technology enhances the precision of smile analysis and provides objective quantitative data.[12]

Dental students represent an ideal population for smile esthetic studies because of their awareness of oral health and esthetics. Evaluating the prevalence of golden percentage among dental students with esthetically pleasing smiles may provide insight into the clinical applicability of mathematical smile theories.

Therefore, the present study was undertaken to evaluate the prevalence of Snow's golden percentage among dental students using a digital smile design approach.

Aim

To evaluate the prevalence of golden percentage among dental students using a digital smile design approach.

Objectives

- To measure the apparent mesiodistal widths of maxillary anterior teeth using digital analysis.
- To calculate the percentage contribution of each maxillary anterior tooth relative to the total anterior width.
- To compare the obtained values with Snow's proposed golden percentage.
- To evaluate the prevalence of golden percentage among individuals with esthetically pleasing smiles.

2. Materials and Methods

Study Design

The present study was designed as an observational cross-sectional study.

Study Population

A total of 25 dental students aged between 18 and 25 years with esthetically pleasing smiles were included in the study.

Inclusion Criteria

Subjects fulfilling the following criteria were included in the study:

- Age between 18 and 25 years
- Presence of esthetically pleasing smile
- Complete set of maxillary anterior teeth
- Absence of dental caries in anterior teeth
- Well-aligned maxillary anterior teeth without crowding or spacing
- No previous orthodontic treatment
- Healthy gingival condition

Exclusion Criteria

Subjects with the following conditions were excluded from the study:

- Missing anterior teeth
- Carious lesions involving anterior teeth
- Crowding or spacing in anterior teeth
- Previous orthodontic treatment
- Restorations involving anterior teeth
- Fractured or malformed anterior teeth
- Attrition or abrasion affecting tooth morphology
- Gingival recession or periodontal disease
- Congenital anomalies affecting tooth size or shape

3. Methodology

Subjects satisfying the inclusion criteria were selected for the study after obtaining informed consent.

Intraoral scanning of the maxillary arch was performed to obtain digital models. The digital models were exported and analyzed using MeshLab software.

The apparent mesiodistal widths of the six maxillary anterior teeth visible from the frontal aspect were measured digitally. Measurements were obtained for:

- Right maxillary canine
- Right maxillary lateral incisor
- Right maxillary central incisor
- Left maxillary central incisor
- Left maxillary lateral incisor
- Left maxillary canine

The total visible width of the six anterior teeth was calculated. The percentage contribution of each tooth relative to the total visible width was determined using the formula:

Percentage width of individual tooth = (Visible width of tooth / Total width of six anterior teeth) × 100

The obtained values were compared with Snow's proposed golden percentage values:

- Central incisors – 25%
- Lateral incisors – 15%
- Canines – 10%

Statistical Analysis

The obtained data were tabulated and analyzed using descriptive statistical methods. Mean values and standard deviations were calculated for all variables.

4. Results

The present study evaluated the prevalence of Snow's golden percentage among 25 dental students with esthetically pleasing smiles using digital smile analysis.

The mean percentage values for the right maxillary canine, lateral incisor, and central incisor were found to be 8.164%, 14.314%, and 18.108%, respectively. On the left side, the mean percentage values for the left central incisor, lateral incisor, and canine were 18.612%, 14.796%, and 8.34%, respectively.

The highest mean percentage values were observed in the maxillary central incisors, whereas the canines demonstrated the lowest percentage values.

None of the evaluated subjects demonstrated exact golden percentage proportions as proposed by Snow.

Table 1: Mean percentage distribution of maxillary anterior teeth

Variables	Right Canine	Right Lateral Incisor	Right Central Incisor	Left Central Incisor	Left Lateral Incisor	Left Canine
Mean percentage	8.164	14.314	18.108	18.612	14.796	8.34
Standard deviation	1.75	1.094	1.81	1.064	1.191	1.704
Rounded percentage	8	14	18	18	15	8

The observed values differed from Snow's proposed ideal percentages. Central incisors exhibited considerably lower percentages than the ideal 25%, whereas the canine values were lower than the ideal 10%. The lateral incisors demonstrated values relatively closer to the proposed ideal percentage.

These findings indicate that naturally esthetic smiles may not necessarily conform to mathematically idealized proportions.

5. Discussion

Smile esthetics has become one of the most important aspects of contemporary dentistry.[3] In recent years, patients have become increasingly aware of facial appearance and smile attractiveness, leading to a greater demand for esthetic dental procedures.[4] As a result, various theories and concepts have been proposed to establish ideal anterior dental proportions.[1,2]

One of the most widely discussed theories in esthetic dentistry is the golden proportion introduced by Levin.[1] This concept was based on the mathematical ratio frequently observed in nature and art.[1] Later, Snow proposed the golden percentage theory, which was considered more clinically practical.[2] According to this concept, the visible widths of maxillary anterior teeth should follow a specific percentage distribution to create an ideal smile.[2]

The present study evaluated the prevalence of Snow's golden percentage among dental students with esthetically pleasing smiles using a digital smile design approach. Interestingly, none of the evaluated subjects demonstrated exact golden percentage values.

The results of the present study revealed that the mean percentage values of maxillary central incisors were approximately 18%, which is considerably lower than Snow's proposed ideal value of 25%.[2] Similarly, the canine values were approximately 8%, which is lower than the ideal value of 10%.[2] The lateral incisors demonstrated values closer to the ideal 15%.

These findings are in accordance with several previous studies that questioned the universal applicability of golden percentage and golden proportion theories.[7,8,10] Many researchers have observed that naturally attractive smiles do not necessarily conform to rigid mathematical formulas.[7]

One possible explanation for the absence of exact golden percentage values may be the subjective nature of smile esthetics.[14] Smile attractiveness is influenced by multiple factors including tooth shape, gingival display, smile arc, lip dynamics, symmetry, and facial harmony.[5,14] Therefore, mathematical proportions alone may not determine esthetic appeal.

Another important factor influencing dental proportions may be ethnicity.[9] Most classical esthetic theories were proposed based on Western populations.[1,2] However, tooth dimensions and facial morphology may vary among different ethnic groups.[9,15] Studies conducted among Asian populations have reported significant variations in anterior tooth proportions when compared with Western standards.[9]

The present study utilized digital smile analysis through intraoral scanning and MeshLab software. Digital dentistry offers several advantages over conventional methods, including increased accuracy, improved reproducibility, reduced operator error, and easier storage of digital records.[12,13]

The use of intraoral scanners eliminates inaccuracies associated with conventional impressions and plaster models.[13] Similarly, digital analysis software allows objective measurement of apparent tooth widths with greater precision.[12]

Modern esthetic dentistry increasingly emphasizes individualized smile design rather than rigid application of mathematical formulas.[4] Every individual possesses unique facial characteristics, smile dynamics, and esthetic preferences. Therefore, clinicians should consider patient-specific features during smile analysis and treatment planning.

The findings of the present study suggest that naturally esthetic smiles may not necessarily exhibit exact golden percentage values. The absence of precise mathematical proportions in subjects with pleasing smiles reinforces the concept that esthetic perception is multifactorial and subjective.[14]

One of the major strengths of the present study is the use of digital technology for smile analysis. The use of intraoral scanning and digital software enhanced measurement accuracy and minimized subjective errors. Furthermore, the study evaluated naturally pleasing smiles rather than artificially designed smiles, thereby providing clinically relevant observations.

However, certain limitations of the study should be acknowledged. The sample size was relatively small, and the study population was limited to dental students within a narrow age range. The selection of esthetically pleasing smiles was subjective and not based on a standardized esthetic scoring system. In addition, only descriptive statistical analysis was performed.

Future studies involving larger sample sizes, diverse ethnic populations, and comparative evaluation of different esthetic concepts are recommended. Further research may also include correlation of smile attractiveness with facial analysis and patient perception.

Despite these limitations, the present study contributes valuable information regarding the applicability of golden percentage in smile esthetics. The findings suggest that clinicians should avoid relying solely on mathematical formulas while designing smiles and should instead focus on individualized esthetic treatment planning.

6. Conclusion

Within the limitations of the present study, it can be concluded that Snow's golden percentage was not consistently observed among dental students with esthetically pleasing smiles.

The observed proportions of maxillary anterior teeth differed from the ideal values proposed by Snow, particularly in the central incisor and canine regions.

These findings suggest that smile esthetics may not be solely dependent on strict mathematical proportions and reinforce the importance of individualized smile design in esthetic dentistry.

7. Limitations of the Study

- Small sample size
- Limited age group
- Subjective evaluation of esthetically pleasing smiles
- Lack of comparison with other esthetic concepts
- Absence of advanced statistical analysis

8. Future Scope

- Studies with larger sample sizes
- Evaluation among different ethnic populations
- Comparative analysis with golden proportion and RED proportion
- Correlation of facial analysis with smile esthetics
- Use of artificial intelligence and advanced digital smile design software for esthetic evaluation

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