AN ANALYSIS OF MAXILLARY CENTRAL INCISOR MORPHOLOGY IN A NORTHEAST THAI YOUNG ADULTS POPULATION USING INTRAORAL SCANNER AND AUTOCAD SOFTWARE

Petcharamon OSATHAPHAN[1*], Ratchada CHAIJIT[1] and Suchart WONGKHANTEE[1]
1 Faculty of Dentistry, Khon Kean University, Thailand;
petcharamon.o@kkumail.com (Corresponding Author)

ARTICLE HISTORY
Received: 6 February 2026 **Revised:** 27 February 2026 **Published:** 13 March 2026

ABSTRACT
The purpose of this study was to analyze the shape of maxillary central incisors in a Northeast Thai young adults population and to evaluate its association with gender stereotypes using a fully digital workflow. A total of 100 participants (50 males and 50 females; 18-35 years) were enrolled after providing informed consent. Maxillary central incisor morphology was recorded using an intraoral scanner. Tooth shape was calculated as the tooth quotient (TQ) classified as square, ovoid, or taper using AutoCAD software. Chi-square was utilized to analyze the relationship between tooth shape and gender ($\alpha = .05$). The result showed that taper was the most overall frequency (42%). According to gender taper was predominant among males (58%), while ovoid was most common in females (48%). Square occurred least frequently in both genders (male 16%, female 24%). A statistically significant association was found between gender and maxillary central incisor tooth shape categories ($p = .017$). Intra-examiner reliability was excellent (ICC = .973). Within the limitations of this study, gender was associated with differences in maxillary central incisor tooth shape distribution. These findings indicate that tooth shape categories may correspond to gender-related characteristics in a Northeast Thai young adults population and may serve as a useful consideration in esthetic smile restoration planning.
Keywords: Tooth Shape, Central Maxillary Incisor, Young Adult Thai Population

CITATION INFORMATION: Osathaphan, P., Chaijit, R., & Wongkhantee, S. (2026). An Analysis of Maxillary Central Incisor Morphology in a Northeast Thai Young Adults Population Using intraoral scanner and AutoCAD Software. *Procedia of Multidisciplinary Research, 4*(3), 18.

INTRODUCTION

The esthetic smile checklist mainly involved the evaluation of the six anterior maxillary teeth (Magne et al., 2003). The maxillary central incisor, as the most visually dominant tooth during speech and smiling (Hussain et al., 2016; Mahn et al., 2018; McGowan, 2016; Trigo-Humaran et al., 2021), is a critical determinant of smile esthetics regarding proportion, position, color, and shape. According to Ong (2006), the shape of the maxillary anterior teeth is a paramount determinant of an attractive smile and is fundamental to developing treatment plans that align with patient expectations in restorative and prosthodontic procedures.

The history of the shape of the maxillary central incisor was first classified by Williams (1914), corresponded to the inverted form of facial shape and categorized into three basic geometric forms: ovoid, square, and tapering. Subsequently, Frush and Fisher (1956) identified a gender association indicating that masculine characteristics were defined by more pronounced angularity and intensity, whilst feminine were represented by more roundness and delicateness. Despite thorough evaluation, these theories remain controversial due to the presence of contradictory evidence regarding their relationship with gender stereotypes (Brunetto et al., 2011; Gobbato et al., 2012; Wolfart et al., 2004). Moreover, existing evidence indicates variations among different countries and ethnic groups; nevertheless, research involving Thai populations remains limited to a single study (Kungsadalpipob et al., 2020).

Various methods were employed for obtaining data and tooth shape measurement. Although conventional impressions and photographic methods were historically popular because of their cost-effectiveness and widespread availability in dental practice (Sayed & Gangadharappa, 2018), they were prone to inaccuracies, particularly distortion in the anterior region of dental casts (Dönmez et al., 2024) and technical variability related to photographic parameters and patient positioning, which compromised the accuracy of anterior tooth surface analysis (Cheung et al., 2024). With advances in modern dentistry, the integration of up-to-date equipment and a fully digital workflow has improved methodological accuracy and efficiency (Brunetto et al., 2011b; Mehndiratta et al., 2019). Intraoral scanners are therefore widely employed to reduce errors inherent in conventional dental impression materials and photographic methods (Kihara et al., 2020).

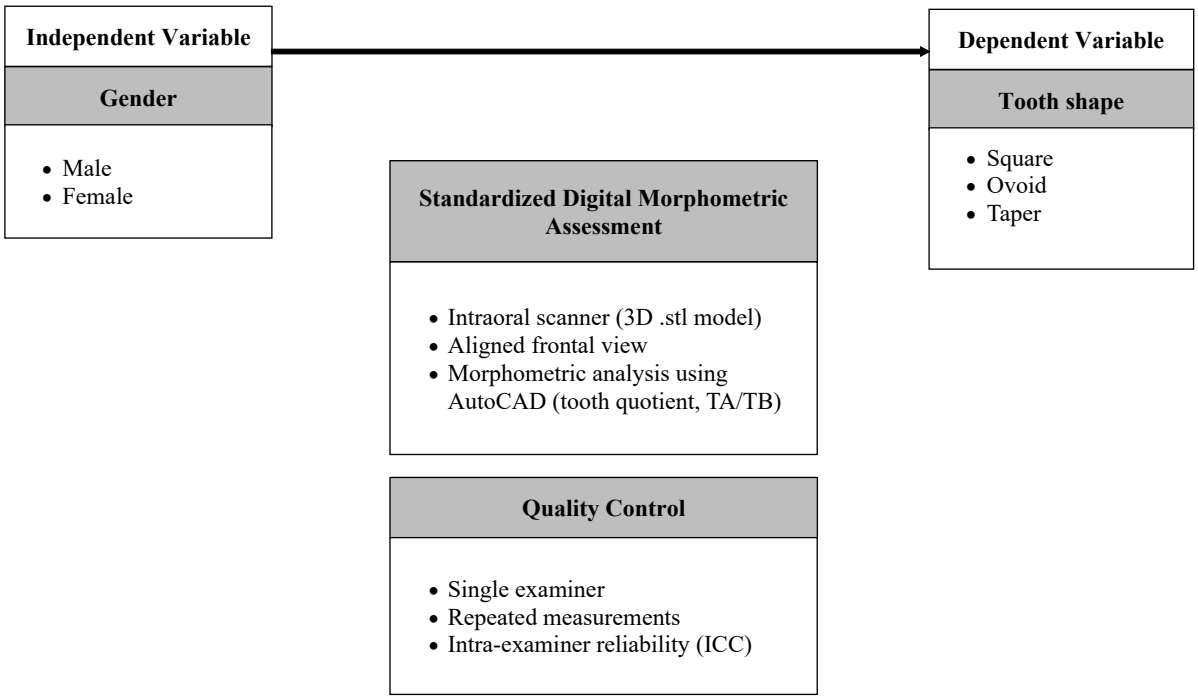
However, limited evidence is available regarding the application of these digital techniques in Thai populations. Therefore, the present study aims to analyze the shape of maxillary central incisors in a Northeast Thai young adults population and to assess its association with gender stereotypes through data acquisition using an intraoral scanner and morphometric analysis using AutoCAD software.

LITERATURE REVIEWS

With growing societal emphasis on self-image and facial appearance, interest in esthetic dentistry has increased substantially (Ortensi et al., 2022). Beyond the eyes, which are the primary focal point during communication, the smile serves as a key secondary element contributing to overall facial attractiveness (Anderson et al., 2005). In smile esthetics, the maxillary anterior teeth are the most essential components (Magne et al., 2003), as they are the first to be visible during smiling and speech, with play crucial role in person's physiological and social well-being. Numerous factors influence smile esthetics, including the width-to-height ratio, tooth proportion, incisal edge level, and lip position (Heravi et al., 2011); however, the factor of greatest concern to patients is tooth shape, particularly that of the maxillary central incisor (Ong et al., 2006). Accordingly, several theories focusing on maxillary central incisor shape have been proposed to establish esthetic guidelines and to improve communication between clinicians and patients in esthetic dental decision-making. The earliest systematic concept relating tooth shape to facial form was proposed by Williams (1914). Known as the *"Law of Harmony,"* this theory describes a correspondence between maxillary central incisor

morphology and the inverted facial shape and continues to be utilized in contemporary prosthodontic practice for artificial tooth selection (Vargas & Margeas, 2021). According to this theory, tooth shape is categorized into three basic forms: square, ovoid, and taper. The square shape exhibits parallel proximal surfaces perpendicular to the incisal edge. The ovoid shape demonstrates biconvex proximal line angles with the contact point located at the middle of the proximal outline. The taper shape is distinguished by convergence of the proximal line angles toward the cervical region, producing a V-shaped cervical outline and a more incisally positioned contact point (Hussain et al., 2016; Leon., 1914; Pavankumar R & Budihal, 2012).
Another influential concept is the "*Dentogenic Theory"* (Frush & Fisher, 1956), which is a relationship between tooth morphology and gender-related personality traits. According to this theory, female tooth forms are characterized by smoother lines and rounded angles, creating impressions of softness, delicacy, and refinement that are traditionally associated with feminine characteristics. These features are commonly expressed through ovoid shapes with rounded contours. In contrast, male tooth forms are described as having sharper angles and well-defined line angles, reflecting masculine traits such as strength, stability, and vigor, which are typically represented by square shape (Wolfart et al., 2004).
Both the law of harmony and dentogenic theory have been widely applied to evaluate tooth form in esthetic and prosthodontic dentistry. Consequently, several studies have been conducted in many populations to determine whether the proposed relationships between tooth shape, facial form, and gender stereotypes are clinically valid. However, the findings remain inconsistent, with some studies supporting these theories, while others have failed to demonstrate significant associations. For example, a study conducted in an Indian cohort of 200 participants found a correlation between maxillary central incisor morphology and inverted facial form, regardless of sex (Koralakunte et al., 2013). Similarly, Brunetto et al. (2011) observed distinct gender-related differences in tooth form distribution. However, other investigations have yielded contradictory findings, failing to confirm the applicability of both the law of harmony and dentogenic theory (Pavankumar & Budihal, 2012; Wolfart et al., 2004).
Previous studies have employed various methods for data collection. Conventionally, irreversible hydrocolloid impressions followed by dental stone cast fabrication have been widely used. However, this technique may lead to inaccuracies, particularly overcontouring of the labial surfaces of anterior teeth, which can influence the accuracy of tooth shape measurements (Dönmez et al., 2024). With advancements in technology, photographic methods have increasingly been adopted, transitioning from analog to digital systems (Schaaf et al., 2009). Digital photography offers advantages such as immediate assessment of image quality, including clarity, illumination, color, and patient positioning. Despite these benefits, potential errors remain, as two-dimensional images are susceptible to distortion related to camera angulation and patient posture (Cheung et al., 2024). Advances in digital dentistry have provided new opportunities to overcome these methodological limitations. The implementation of a fully digital workflow, incorporating intraoral scanning and computer-aided morphometric analysis, has been shown to improve measurement accuracy and efficiency compared with conventional impression and photographic techniques. Intraoral scanners demonstrate high accuracy in terms of both precision and trueness. In addition, their use is associated with improved patient satisfaction due to increased comfort, reduced chairside time, and a lower incidence of gag reflex (Kihara et al., 2020). However, empirical evidence supporting the use of digital techniques for tooth shape assessment in Thai populations is scarce. To date, only a single study has utilized visual assessment based on photographic analysis to investigate the relationship between tooth form and gingival phenotype (Kungsadalpipob et al., 2020). Accordingly, the present study seeks to evaluate the morphology of maxillary central incisors in a Northeast Thai young adults population and to examine its association with gender stereotypes through intraoral scanning and morphometric analysis using AutoCAD software.

Conceptual Framework



Hypothesis

There is no significant difference in the morphology of maxillary central incisors between male and female individuals in a Northeast Thai population.

METHODS

This study had been reviewed by the Khon Kaen University Ethics Committee for Human Research based on the Declaration of Helsinki and the ICH Good Clinical Practice Guideline. A total of 100 participants (50 males and 50 females; age range = 18-35 years) from five major cities in northeastern Thailand who were studying at Khon Kaen University were randomly selected for this study. All participants provided written informed consent prior to enrollment. Inclusion criteria were fully erupted maxillary central incisor and first molar with healthy gingival tissues. Exclusion criteria included restorations of the right maxillary central incisor, ongoing orthodontic treatment, dental caries, cervical lesions, severe fluorosis, or severe crowding that could affect tooth morphology.

Intraoral scanning procedure

The subjects were in a supine position. A retractor (OptraGate, Ivoclar) was places intraorally and dry the tooth with air from triple syringe. An intraoral scanner (Trios 5; 3SHAPE, Copenhagen, Denmark) was used to capture intraoral data. Maxillary arch scanning was performed in accordance with the manufacturer's recommended protocol. Briefly, the occlusal surfaces were scanned first, with the scanner tip maintained at a distance of approximately 0-5 mm from the tooth surfaces. This was followed by scanning of the buccal and palatal surfaces, during which the scanner tip was rotated 45°-90° toward the buccal and lingual aspects using a slow, continuous sweeping motion. All scans were acquired in the same clinical environment. To minimize operator-related variability, a single experienced dentist performed all scans using the same intraoral scanner.

Tooth shape determination

Intraoral scan files were exported in .STL format. Three-dimensional models were standardized in the frontal view by aligning the dental midline parallel to the X-axis and perpendicular to the Y-axis. The occlusal plane, defined by the most incisal point of the maxillary central incisor

and the mesiobuccal cusp tip of the maxillary first molar, was oriented at an 8° angle to the Z-axis, consistent with the reported average Frankfort horizontal-occlusal plane relationship in the Thai population (Srisettanil, 2013). A frontal image of the right maxillary central incisor was then captured and saved in .JPEG format for morphometric analysis.

The tooth shape was analyzed using AutoCAD software (AutoCAD 2025; Auto Desk, San Rafael, Calif). All assessments were conducted by a single calibrated examiner using the following standardized procedures (Figure 1): The tooth outline was traced, and a median line was drawn to identify point X at the most apical intersection with the outline. Mesial and distal tangent lines, parallel to the median line, were constructed to contact the tooth outline. Perpendicular reference lines were dropped to define points S1 (most apical) and S2 (most incisal) on the median line; their midpoint was designated as point S. A baseline (TB) perpendicular to the median line was drawn through point S to the tooth outline. The distance XS was divided into five equal segments, and a parallel line (TA) was constructed at one-fifth of XS from the cervical end. The tooth quotient (TQ = TA/TB) was calculated and used to classify maxillary central incisor shape as follows: square (TQ ≥ 0.70), ovoid (TQ > 0.61 and < 0.70), and taper (TQ ≤ 0.61). The analysis was repeated twice at a 1-week interval to minimize memory-related bias.

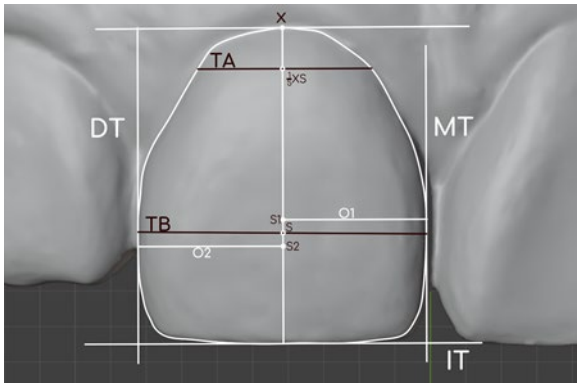


Figure 1 Measurement for maxillary central incisor shape classification. Reference lines and points were established to calculate the tooth quotient (TQ = TA/TB), which was used to categorize tooth shape as square, ovoid, or taper.

Statistics SPSS software (version 28.0.0.0: SPSS Inc, Chicago, Illinois, USA) was used for data analysis. The proportion of the shape of the maxillary central incisor in the northeast Thai population was assessed using descriptive analysis by percentage. Statistical analysis using Pearson's chi-square test to assess the association between gender and maxillary central incisor tooth shape categories. Intra-examiner reliability was evaluated using the intraclass correlation coefficient (ICC), calculated for both single-measure and average-measure models, with 95% confidence intervals.

RESULTS

One hundred participants who provided written informed consent were included in the analysis (50 males and 50 females), with a mean age of 25.14 years (SD = 5.20). The distribution of maxillary central incisor tooth forms is presented in Table 1. Analysis of the overall sample revealed that taper was predominant (42%), followed by ovoid (38%), with square occurring least frequently (20%). According to gender, among male participants, taper was the most prevalent (56%), followed by ovoid (28%) and square (16%). In contrast, female participants, most frequently exhibited ovoid (48%), followed by taper (28%) and square (24%). A Pearson chi-square test revealed a statistically significant association between gender and maxillary central incisor tooth shape (p = .017).

Table 1 Distribution of maxillary central incisor tooth forms by gender

Gender	Tooth shape Number (%)			Total
	Square	Ovoid	Taper	
Male	8 (16)	14 (28)	28 (56)	50 (100)
Female	12 (24)	24 (48)	14 (28)	50 (100)
total	20 (20)	38 (38)	42 (42)	100 (100)

* no cells had expected counted less than five.

Intra-examiner reliability was excellent (ICC_single = .947, 95% CI [.923, .964]; ICC_average = .973, 95% CI [.960, .982]), indicating high consistency across repeated measurements by a single examiner.

DISCUSSION & CONCLUSION

The present study examined the distribution of maxillary central incisor tooth shapes in a Northeast Thai population and evaluated their association with gender using a fully digital workflow. A statistically significant association between gender and tooth shape distribution was identified. Thus, null hypothesis was rejected within this population. Comparable findings were reported by Brunetto et al. (2011), who demonstrated that significant gender differences were present in angular tooth forms—specifically taper and square —whereas the ovoid exhibited similar prevalence between males and females and did not show a statistically significant gender association. In contrast to those studies of Mehndiratta et al. (2019) and Wolfart et al. (2004), who found the inability to relate tooth form to gender.

The higher prevalence of ovoid among female participants in the present study is consistent with the Dentogenic theory; however, the predominance of taper among males deviates from the expected square. In contrast, Wolfart et al. (2004) reported a higher prevalence of square tooth forms in males and triangular forms in females in a Caucasian population, while a Brazilian study identified the ovoid form as the most prevalent in both genders (Brunetto et al., 2011). These inconsistencies suggest that Dentogenic principles may be more applicable to female tooth morphology and should be applied with caution when interpreting in male.

Variations in the distribution of maxillary central incisor tooth shapes have been reported across regions and countries. While studies conducted in Brazilian (Brunetto et al., 2011), German (Wolfart et al., 2004), and Indian (Mehndiratta et al., 2019) populations have identified the ovoid form as the most prevalent, findings from Thai populations differ. In both the present study and the study by Kungsadalpipob et al. (2020), the taper form was the most commonly observed maxillary central incisor shape. These differences further support the notion that maxillary central incisor morphology is population-specific and influenced by ethnic factors.

Basic geometric tooth shapes have been widely used for classification in numerous studies because they provide a simple and practical framework supported by standardized criteria proposed in the literature. However, Mahn et al. (2018) reported that pure basic tooth forms were less common than hybrid forms that combine characteristics of two shapes, such as triangular-ovoid or ovoid-rectangular configurationsIn particular, the triangular-ovoid configuration has been identified as the most preferred tooth shape (Hussain et al., 2016). These findings suggest that future investigations should consider incorporating combined or hybrid tooth shape classifications to better reflect the natural variability of dental morphology.

Methodologically, the use of a fully digital workflow represents a significant strength of this study. Intraoral scanning allowed for accurate three-dimensional data acquisition without the distortions associated with conventional impression materials or two-dimensional photography (Kihara et al., 2020). The application of standardized morphometric analysis using AutoCAD software enabled objective calculation of the tooth quotient, reducing examiner subjectivity

(Brunetto et al., 2011). Furthermore, excellent intra-examiner reliability confirmed the consistency of repeated measurements, supporting the internal validity of the findings. These methodological advantages may partly explain differences between the present results and those of earlier studies that relied on visual or manual assessments.

From a clinical perspective, the demonstrated association between gender and maxillary central incisor tooth shape has implications for esthetic smile design and restorative treatment planning. While patient preferences (Anderson et al., 2005) and individual facial characteristics should remain the primary determinants of esthetic outcomes, awareness of population-specific tooth shape tendencies may assist clinicians in achieving harmonious and culturally appropriate restorations. The findings suggest that tooth shape categories may be associated with gender-related characteristics in a Northeast Thai young adults population and could be considered as one of several factors in esthetic smile restoration planning.

Recommendations for Future Research

Several limitations should be acknowledged. The study sample was limited to young adults from a Northeast Thai population, which may restrict the generalizability of the findings to other age groups or ethnic backgrounds. Additionally, although measurement reliability was high, the use of a single examiner may introduce systematic bias. Future research incorporating larger, multi-center samples, and patient-centered esthetic evaluations would further elucidate the complex relationships among tooth shape, gender, and facial characteristics.

REFERENCES

Anderson, K. M., Behrents, R. G., McKinney, T., & Buschang, P. H. (2005). Tooth shape preferences in an esthetic smile. *American Journal of Orthodontics and Dentofacial Orthopedics, 128*(4), 458-465.

Brunetto, J., Becker, M. M., & Maziero Volpato, C. A. (2011). Brunet to et al Clinical Implications Gender differences in the form of maxillary central incisors analyzed using AutoCAD software. In *J Prosthet Dent (Vol. 106)*.

Cheung, K., Cheung, W., Liu, Y., Ye, H., Lv, L., & Zhou, Y. (2024). Establishment of a 3D esthetic analysis workflow on 3D virtual patient and preliminary evaluation. *BMC Oral Health, 24*(1).

Dönmez, M. B., Wepfer, A. B., Güven, M. E., Çakmak, G., Schimmel, M., & Yilmaz, B. (2024). Dimensional Stability of Additively Manufactured Diagnostic Maxillary Casts Fabricated with Different Model Resins. *The International Journal of Prosthodontics, 37*(7), 119-126.

Frush, J. P., & Fisher, R. D. (1956). How dentogenic restorations interpret the sex factor. *The Journal of Prosthetic Dentistry, 6*(2), 160-172.

Gobbato, L., Tsukiyama, T., Levi, P. A., Griffin, T. J., & Weisgold, A. S. (2012). Analysis of the shapes of maxillary central incisors in a Caucasian population. *The International Journal of Periodontics & Restorative Dentistry, 32*(1), 69-78.

Heravi, F., Rashed, R., & Abachizadeh, H. (2011). Esthetic preferences for the shape of anterior teeth in a posed smile. *American Journal of Orthodontics and Dentofacial Orthopedics, 139*(6), 806-814.

Hussain, A., Louca, C., Leung, A., & Sharma, P. (2016). The influence of varying maxillary incisor shape on perceived smile aesthetics. *Journal of Dentistry, 50*, 12-20.

Kihara, H., Hatakeyama, W., Komine, F., Takafuji, K., Takahashi, T., Yokota, J., Oriso, K., & Kondo, H. (2020). Accuracy and practicality of intraoral scanner in dentistry: A literature review. *Journal of Prosthodontic Research, 64*(2), 109-113.

Koralakunte, P. R., Budihal, D. H., & Basavapura, N. D. (2013). A Classification of Face Form and Tooth Form-An Invivo Study. In *International Journal of Innovative Medicine and Health Science (Vol. 1)*.

Kungsadalpipob, K., Jamsakorn, K., Pumnil, S., & Sutthiboonyapan, P. (2020). Analysis of Maxillary Incisor Tooth Dimensions and Gingival Phenotype in Thai Young Adults. *J Dent Assoc Thai, 70*(3).

Leon., W. J. (1914). A new classification of human tooth forms with special reference to a new system of artificial teeth. *Dental Cosmos, 56*, 627-628.

Magne, P., Dent, M., Gallucci, G. O., & Belser, U. C. (2003). Anatomic crown width/length ratios of unworn and worn maxillary teeth in white subjects. *The Journal of Prosthetic Dentisty, 89*(5), 453-461.

Mahn, E., Walls, S., Jorquera, G., Valdés, A. M., Val, A., & Sampaio, C. S. (2018). Prevalence of tooth forms and their gender correlation. *Journal of Esthetic and Restorative Dentistry, 30*(1), 45-50.

McGowan, S. (2016). Characteristics of Teeth: A Review of Size, Shape, Composition, and Appearance of Maxillary Anterior Teeth. *Compendium of Continuing Education in Dentistry (Jamesburg, N.J. : 1995), 37*(3), 164-171.

Mehndiratta, A., Bembalagi, M., & Patil, R. (2019). Evaluating the Association of Tooth Form of Maxillary Central Incisors with Face Shape Using AutoCAD Software: A Descriptive Study. *Journal of Prosthodontics, 28*(2), e469-e472.

Ong, E., Brown, R. A., & Richmond, S. (2006). Peer assessment of dental attractiveness. *American Journal of Orthodontics and Dentofacial Orthopedics, 130*(2), 163-169.

Ortensi, L., Sigari, G., La Rosa, G. R. M., Ferri, A., Grande, F., & Pedullà, E. (2022). Digital planning of composite customized veneers using Digital Smile Design: Evaluation of its accuracy and manufacturing. *Clinical and Experimental Dental Research, 8*(2), 537-543.

Pavankumar R, K., & Budihal, D. H. (2012). A clinical study to evaluate the correlation between maxillary central incisor tooth form and face form in an Indian population. *Journal of Oral Science, 54*(3), 273-278.

Sayed, M., & Gangadharappa, P. (2018). Three-dimensional evaluation of extended pour alginate impression materials following variable storage time intervals and conditions. *Indian Journal of Dental Research, 29*(4), 477-486.

Schaaf, H., Malik, C. Y., Howaldt, H.-P., & Streckbein, P. (2009). Clinical, Cosmetic and Investigational Dentistry evolution of photography in maxillofacial surgery: from analog to 3D photography-an overview. In *Clinical, Cosmetic and Investigational Dentistry*.

Srisettanil, S. (2013). *Agreement of Cephalometric Interpretation between Intracranial Reference Lines and Extracranial Reference Lines*. Prince of Songkla University.

Trigo-Humaran, M. M., Agüero-Romero, A. B., Lespade, M., García-Cuerva, J. M., & Iglesias, M. E. (2021). Central incisors shape and proportions prevalence in Argentinian university students: by visual assessment and a new standardized method. *Acta Odontologica Latinoamericana : AOL, 34*(2), 113-118.

Vargas, M. A., & Margeas, R. (2021). A systematic approach to contouring and polishing anterior resin composite restorations: A checklist manifesto. *Journal of Esthetic and Restorative Dentistry, 33*(1), 20-26.

Wolfart, S., Menzel, H., & Kern, M. (2004). Inability to relate tooth forms to face shape and gender. *European Journal of Oral Sciences, 112*, 471-476.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.