Original Article

pISSN, eISSN 0125-5614
M Dent J 2019; 39 (2) : 107-114

Relationship between smile line, gingival biotype, tooth shape, and gingival zenith of maxillary central incisiors in a group of Thai young adults

Supranee Benjapupattananan, Papatpong Sirikururat

College of Dental Medicine, Rangsit University

Objectives: To evaluate the relationship between smile line, gingival biotype, tooth shape, smile line and gingival zenith in a group of Thai young adults.

Materials and Methods: One hundred and three Thai young adults; 43 males and 60 females, aged between 18 to 35 years old participated in the study. Two photographs were taken from each volunteer, including maximum smile and lip retracted for data collecting of gingival zenith and tooth shape with 2-mm diameter reference dot. The classification of gingival biotype was performed by insertion of periodontal probe at labial aspect of gingival sulcus. Chi-square test was used to evaluate the relationship between smile line, gingival biotype, tooth shape, and gingival zenith with statistical significance of 95%.

Results: There was no statistical evidence that smile line were related to tooth shape, gingival biotype and gingival zenith. However, the relationship between tooth shape and gingival biotype showed statistically significant ($p<0.05$). Ovoid tooth shape had the tendency to relate with thick gingival biotype, whereas triangular tooth shape appeared to show the relation to thin gingival biotype. Moreover, the statistical result showed that square tooth shape did not relate with gingival biotype.

Conclusions: Thick gingival biotype was likely to be observed in ovoid tooth shape, while triangular tooth shape was quite common with thin gingival biotype.

Keywords: smile line, tooth shape, gingival biotype, gingival zenith

How to cite: Benjapupattananan S, Sirikururat P. Relationship between smile line, gingival biotype, tooth shape, and gingival zenith of maxillary central incisiors in a group of Thai young adults. M Dent J 2019; 39: 107-114.

Introduction

In social interaction, facial appearance has become vital as it has many morphological elements. Because the mouth is the center of communication within the face, the smile performs a crucial function in facial esthetics, expression and appearance. The smile arc and the position of maxillary anterior teeth including healthy periodontium are the key esthetic factors of a smile. Smile line can be classified into low, average and high smile line according to visibility of tooth and gingiva during smiling. [1] High smile line is regarded as “gummy smile” which is recognized undesirable appearance.

Gingival biotypes, the thickness of gingiva in facio-palatal dimension, were divided by Seibert and Lindhe as thick flat and thin scalloped biotypes. [2] Thick biotype is dense and fibrotic attachment with wide board band of keratinized tissue, while thin biotype is more translucency, highly scalloped and tendency to recession. The shape of the teeth is related to the thickness of gingiva and surrounding bone. [3] Previous studies has been suggested that thin gingival biotype associated with triangular crown morphology, subtle cervical convexity and minute proximal

Correspondence author: Papatpong Sirikururat
College of Dental Medicine, Rangsit University
52/347 Muang-Ake, Phaholyothin Road, Lak-Hok, Muang Pathumthani, 12000 Thailand
Tel. 02-9972200-30 ext.4348 Fax. 027916000 Email address: papatpong.s@rsu.ac.th
Received : 4 April 2019 Accepted : 11 July 2019

contact areas located near the coronal third of the tooth. [4, 5] Teeth with short but wide crowns and large contact areas seem to be associated with a less scallop gingival margin, a thick soft tissue complex and a thick bony housing. [6] Thus, the tooth shape appears to be correlated with the soft tissue quality. Otherwise, the size and shape of teeth differ among race, region, gender, and dietary habits. [4]

The gingival zenith (GZ) is defined as the most apical point of marginal gingival scallop. In aesthetic dentistry, the gingival zenith is primary essential component of a beautiful smile. The gingival zenith position (GZP) from vertical bisected midline (VBM) in maxillary anterior teeth has been studied, which in central incisor located distal to VBM 0.95 - 1.00 mm. [7, 8] The studies to assess the association of smile line, gingival biotype, tooth shape, and gingival zenith are few in dental literature, especially in Thai population. The purpose of this study was to determine the relevance form of smile line in relation to gingival biotype, tooth shape and gingival zenith in a group of Thai young adults.

Materials and methods

The study was ethical approved by Research Ethical Committee, Rangsit University (RSEC 61/2560). This cross sectional clinical study recruited 103 healthy Thai young adults age between 18 to 35 years old. All the participants were informed about the objective and process of the study before signing the informed consent. The exclusion criterion were subjects with obvious dentofacial disharmonies, severe maxillary anterior crowding and malposition, facial paralysis or lip irregularities, gingival recession or interproximal tissue loss, incisal wear ≥ 1 mm, spacing or anterior cross bite, prosthesis or restoration in maxillary anterior region, dental caries or undergone restoration which including interproximal surfaces.

Digital extra-oral and intra-oral photographs were taken from each participant by digital camera (Canon 700 D camera macro lens 100 mm with ring flash Canon MR 14EX II, 1/25 shutter speed, f32 and ISO 800). The extra-oral photographs with maximum smile were taken in upright position on dental chair. After that, supine position was set and the intra-oral photographs with lip retraction a and 2-mm diameter reference dot placing on the middle of the labial surface of maxillary right central incisor were photographed to collect data of gingival zenith and tooth shape. The measurement of all data were performed on left maxillary central incisor except classification of smile line which was determined from the maximum smile photographs. All photographs and measurements were analysed by using ImageJ software (version 1.8.0; National Institutes of Health)

The tooth dimensions were measured in vertical and horizontal aspects for calculating the tooth ratio as following;

1. Clinical crown length (CL): the longest apico-coronal distance (parallel to the long axis) of the tooth, from incisal edge to gingival zenith.

2. Cervical width of the clinical crown (CW): the mesio-distal width of crown at the junction between the middle 1/3 and cervical 1/3 of the crown length. (Figure1)

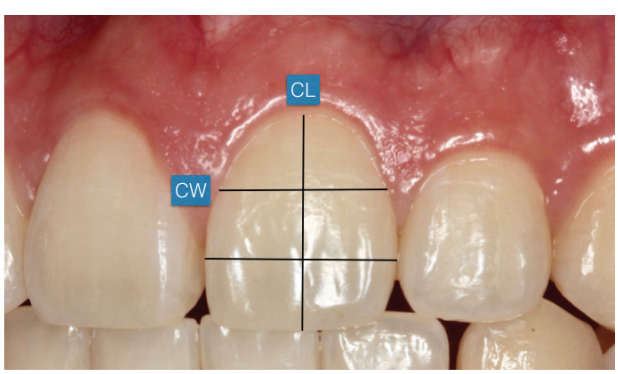

Figure 1 Cervical width of the clinical crown (CW) and clinical crown length (CL) were verified by the image-processing program (Image J, National Institutes of Health) which were converted all distances into millimeters.

Measuring distances of CW and CL were performed on tooth 21 by using 2-mm diameter reference dot that was placed on midfacial aspect of tooth 11 as a reference for calibrating the actual distances. The calculated ratio of CW/CL was classified tooth shape in which ≤ 0.66 as triangular tooth shape, 0.67 - 0.76 as ovoid tooth shape and ≥ 0.79 as square tooth shape. [9] Then the gingival zenith position (GZP), the highest point of free gingival margin, was measured. Measurement of vertical bisected midline (VBM) was performed to define VBM of each clinical crown, the tooth width was measured at two reference points. The proximal-incisal contact area position and the apical contact area position served as the reference points. Both points were joined in mesio-distal direction, and the center was marked for each line. A line joining the two centers was then extended till the gingiva to establish the VBM. The highest point of the free gingival margin was measured from VBM along the long axis of left maxillary central incisor to obtain the gingival zenith position (GZP) in a medial-lateral direction. [7] GZP was classified in 3 categories which are ≤ 0.5 mm from VBM, > 0.5 to ≤1mm from VBM, > 1 mm from VBM.

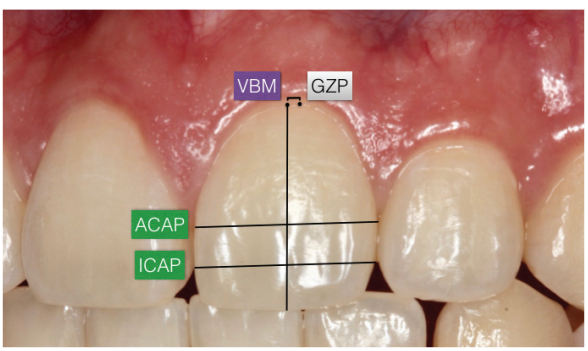

Figure 2 To define the vertical bisected midline (VBM) of each clinical crown, the tooth width was measured at two reference points. The proximal incisal contact area position (ICAP) and the apical contact area position (ACAP) served as reference points. Each width was divided in half, and the center points were marked. Center points were extended to a line toward the gingival aspect of the clinical crown to define VBM. The distance was measured from VBM to the gingival zenith position (GZP) in a medial-lateral direction.

Gingival biotype was considered by sulcus probing at the midfacial aspect of tooth 21. Gingival biotype was categorized as either thin or thick according to the visibility of the underlying periodontal probe through the gingival tissue (visible = thin biotype, not visible = thick biotype). [10]

The smile line was classified as low, average and high smile line. The average smile line reveals 75 to 100% of maxillary anterior teeth and the inter proximal gingiva. The high smile line displayed the total cervico-incisal length of the maxillary anterior teeth and a contiguous band of gingiva. The low smile line displayed less than 75% of clinical crown height of maxillary anterior teeth. [1]

Chi-square test at significance level 0.05 was used to evaluate the relationship of each variants including gender, type of smile line, tooth shape ,gingival biotype and gingival zenith.

Results

The study recruited 103 left maxillary central incisors from 103 healthy subjects (43 males and 60 females) with the range of age 18 to 32 years old (mean ± SD 23.5 ± 2.3). Almost half of total participants have average smile line (47.6%), followed by high smile line (30.1%) and low smile line (22.3%). Proportions of each tooth shape were quite similar. There were 35.0% of triangular tooth shape, followed by 34.0% of ovoid tooth shape and 31.1% of square tooth shape. Moreover, nearly two-third or 68.0% of participants had thick gingival biotype. The rest or 32.0% of participants had thin biotype. Lastly, gingival zenith was measured and grouped into three ranges, which are less than or equal to 0.5 mm (≤ 0.5 mm), higher than 0.5 mm but lower than or equal to 1 mm (> 0.5 mm to ≤ 1 mm) and higher than 1 mm (> 1 mm). 68.0% of participants fell into the second group (> 0.5 mm to ≤ 1 mm). Besides, 25.2% of participants were over range > 1mm and there were only 6.8% in the group of ≤ 0.5 mm. (Table1)

Table 1 Frequency table to describe number of observations and percentage of the variables

Variables		Frequency	Percentage
Gender	Male	43	41.7
	Female	60	58.3
	Total	103	100.0
Smile Line	High	31	30.1
	Average	49	47.6
	Low	23	22.3
	Total	103	100.0
Tooth Shape	Square	32	31.1
	Triangular	36	35.0
	Ovoid	35	34.0
	Total	103	100.0
Gingival Biotype	Thick	70	68.0
	Thin	33	32.0
	Total	103	100.0
Gingival Zenith	Less than or equal to 0.5 mm (≤ 0.5 mm)	7	6.8
	Higher than 0.5 mm but less than or equal to 1 mm (> 0.5 mm to ≤ 1 mm)	70	68.0
	Higher than 1 mm (> 1 mm)	26	25.2
	Total	103	100.0

20 out of 103 participants showed average smile line and triangular tooth shape, followed by 17 participants with average smile line and ovoid tooth shape and 13 participants with high smile line and square tooth shape. On the other hand, the smallest groups had only 7 participants, which had high smile line and triangular tooth shape, low smile line and square tooth shape, and low smile line and ovoid tooth shape. For the relation between smile line and biotype, the biggest group was average smile line and thick gingival biotype, which was 33 participants in this group. The second group had 20 participants, which had high smile line and thick gingival biotype. And the smallest group is low smile line and thin gingival biotype. Lastly, referring to Table 2, the biggest group of participants was average smile line and gingival zenith which ranged between 0.5 mm and 1 mm. The second and third groups were high smile line and low smile line with the same gingival zenith range; between 0.5 mm and 1 mm, which were 20 participants and 19 participants, respectively. After the Pearson Chi-Square test was performed. The values were higher than significance level 0.05. As a result, there were no relationship between smile line and tooth shape, smile line and gingival biotype, and smile line and gingival zenith. (Table 2)

Table 2 Number of participants between smile line and tooth shape or gingival biotype or gingival zenith.

Number of participants		Tooth Shape			Gingival Biotype		Gingival Zenith		
		Square	Triangular	Ovoid	Thick	Thin	≤ 0.5 mm	> 0.5 mm to ≤ 1 mm	> 1 mm
Smile Line	High	13	7	11	20	11	3	20	8
	Average	12	20	17	33	16	2	31	16
	Low	7	9	7	17	6	2	19	2
	Total	32	36	35	70	33	7	70	26

al biotype or gingival zenith.

Table 3 showed that 28 of 103 participants presented ovoid tooth shape and thick gingival biotype, which was the largest group, followed by square tooth shape and thick gingival biotype in 23 participants. In contrast, the smallest group remained only seven participants. They were the combination of ovoid tooth shape and thin gingival biotype. Furthermore, the gingival zenith range between 0.5 mm and 1 mm had the highest number of participants at 70, and they also have almost same number of participants across three types of tooth shape; 24 for square tooth shape and 23 for triangular and ovoid tooth shape. The other groups of gingival zenith position had number of participants which were less than or equal to 10 across all tooth shape subgroups. Pearson Chi-Square statistics was 6.366, with Asymptotic Significance 0.041. The p-value was lower than 0.05, which was significance level. In other words, it means that there was a relationship between tooth shape and gingival biotype. It seemed that ovoid tooth shape showed to present thick gingival biotype; whereas, triangular tooth shape tended to have thin gingival biotype. On the other hand, the statistical results showed that square tooth shape did not relate with gingival biotype. Moreover, data from Table 3 revealed that there is no relationship between tooth shape and gingival zenith.

From Table 4, it was clearly seen that thick gingival biotype with gingival zenith range between 0.5 mm and 1 mm had the biggest number of participants (47 participants). Furthermore, the second biggest group was a combination between thin gingival biotype and gingival zenith between 0.5 mm and 1 mm, with 23 participants. Nevertheless, there was one combination that has only one participant, which was thin gingival biotype and gingival zenith less than or equal to 0.5 mm. The value of Pearson Chi-Square is 1.114 with Exact Sig. 0.646. Consequently, it could be concluded that gingival biotype had no relationship with gingival zenith.

Table 3 Number of participants between tooth shape and gingival biotype or gingival zenith.

Number of participants		Gingival Biotype		Gingival Zenith		
		Thick	Thin	≤ 0.5 mm	> 0.5 mm to ≤ 1 mm	> 1 mm
Tooth Shape	Square	23	9	2	24	6
	Triangular	19	17*	3	23	10
	Ovoid	*28**	7	2	23	10
	Total	70	33	7	70	26

**statistically significant with p value < 0.05*

Table 4 Number of participants between gingival biotype and gingival zenith.

Number of participants		Gingival Zenith		
		≤ 0.5 mm	> 0.5 mm and ≤ 1 mm	> 1 mm
Gingival Biotype	Thick	6	47	17
	Thin	1	23	9
	Total	7	70	26

Discussion

The smile line types of 103 Thai young adult participants presented average smile line, high smile line and low smile line about 47.6%, 30.1%, and 22.3% respectively. In this study, most subjects showed average smile line followed by high smile line and low smile line respectively that were different from those reported by Tjan and coworkers, on American youths with 454 full-face photographs of students with maximum smiles. The subjects were 207 men and 247 women from 20 to 30 years of age. The subjects were classified as average, low, and high smile line in which 68.94%, 20.48%, and 10.57% respectively. [1] The differences clearly exist based on race, when comparing Thai subjects with those of Caucasian descent, and gender. The results of present study were also different from those reported by Liang and colleagues, two-hundred young Chinese-Han nationality subjects (100 men and 100 women; 20–35 years of age) with healthy dentogingival tissue were recruited. [11] The dynamic smile process was captured using a digital camera showed that average smile line, low smile line and high smile line were present 60.6%, 33.5% and 5.9% respectively. This could be explained by the difference between ratio of subject gender. The result of present study, there were more female subjects (female:male=60:43) than Liang and colleagues' study (female:male= 100:100). And the study showed that female had higher tendency to have high smile line. [1]

From the study of Chu and coworkers, a total of 240 sites in 20 healthy patients with an average age of 27.7 years were evaluated. GZP dimensions were measured with calibrated digital callipers for each individual tooth on diagnostic cast and within each tooth group in a medial-lateral direction from the VBM. The investigation revealed a GZP mean value of 1 mm distally from VBM for the central incisors. [7] Similarly, our result revealed that the majority of gingival zenith of maxillary central incisor was between 0.5 mm to 1 mm from VBM.

The results of present study found that there was relationship between tooth shape and gingival biotype among the subjects by statistical analysis between the collected data. The result showed that triangular tooth shape associated with thin gingival biotype which in accordance with data reported by Olsson & Lindhe who showed clinical photographs of the maxillary incisor tooth region of 113 subjects. CL and CW of the clinical crowns were determined and the CW/CL ratio was calculated for each tooth. The study showed that subjects with long narrow teeth (triangular tooth shape) have a comparatively thin periodontium.[4] The results of present study were also in accordance from those reported by De Rouck and colleagues. Thin gingiva was found in mainly female subjects with slender teeth (triangular tooth shape), a narrow zone of keratinized tissue and a highly scalloped gingival margin corresponding to the features of the previously introduced "thin-scalloped biotype". [12] However, the results of present study also showed that ovoid tooth shape related with thick

gingival biotype which were different from previous report, which found that thick gingiva was found in sample in mainly male subjects, quadratic teeth (square tooth shape), a broad zone of keratinized tissue and a flat gingival margin corresponding to the features of the previously introduced as "thick-flat biotype". [12] The results of the present study were also different from another study which found that there was no relationship between biotype and tooth height-to-width ratio or facial recession. However, that study found that gingival biotype was significantly related to labial plate thickness. [13] Moreover, our results were different from those reported by AlQahtani and coworkers, which found the statistically significant association between thick gingival biotype and square tooth shape while our results showed that ovoid tooth shape significantly associated with thick gingival biotype, and triangular tooth shape associated with thin gingival biotype. [14] In summary, the results from present study might be different from others due to the differences in sample size and ethnicity.

Conclusion

There is a relationship between the tooth shape and the gingival biotype in Thai young adults. The thick gingival biotype was likely to be observed in ovoid tooth shape while the thin gingival biotype was often observed in triangular tooth shape. Nevertheless, the statistical results showed that the square tooth shape did not relate with the gingival biotype.

Acknowledgements

The authors would like to thank all volunteers for dedicating the time to the project. In addition, we are grateful to Miss Wirada Kunachaichote, Miss Nutchanun Wiwatsombat, Miss Chanisara Boolsin, Miss Chutipa Sirithienthong, and Mr. Tripetch Jantarasut for their devoted assistance to successfully completing this project work.

References

1. Tjan AH, Miller GD, & The JG. Some esthetic factors in a smile. *J Prosthet Dent* 1984; 51: 24-8
2. Seibert J, & Lindhe J. Esthetics and periodontal therapy. In: Lindhe J (ed) Textbook of Clinical Periodontology, second ed. Copenhagen: Munksgaard. 1989: 477-514
3. Sanavi F, Weisgold AS, & Rose LF. Biologic width and its relation to periodontal biotypes. *J Esthet Dent* 1998; 10: 157-63
4. Olsson M, & Lindhe J. Periodontal characteristics in individuals with varying form of the upper central incisors. *J Clin Periodontol* 1991; 18: 78–82
5. Olsson M, Lindhe J, & Marinello CP. On the relationship between crown form and clinical features of the gingiva in adolescents. *J Clin Periodontol* 1993; 20: 570-77
6. Weisgold AS. Contours of the full crown restoration. *Alpha Omegan* 1977; 70: 77-89
7. Chu SJ, Tan JHP, Stappert CF, & Tarnow DP. Gingival zenith positions and levels of the maxillary anterior dentition. *J Esthet Restor Dent* 2009; 21: 113-20
8. Shah D, Vaishnav K, Duseja S, & Agrawal P. Relative position of gingival zenith in maxillary anterior teeth-a clinical appraisal. *Int J Health Biomed Res* 2014; 3: 77-81
9. Song JW, Leesungbok R, Park SJ, Chang SH, Ahn SJ, & Lee SW. Analysis of crown size and morphology, and gingival shape in the maxillary anterior dentition in Korean young adults. *J Adv Prosthodont* 2017; 9: 315-20
10. Kan JY, Morimoto T, Rungcharassaeng K, Roe P, & Smith DH. Gingival biotype assessment in the esthetic zone: visual versus direct measurement. *Int J Periodontics Restorative Dent* 2010; 30: 237-43
11. Liang LZ, Hu WJ, Zhang YL, Chung, KH. Analysis of dynamic smile and upper lip curvature in young Chinese. *Int J Oral Sci* 2013; 5: 49–53
12. De Rouck T, Eghbali R, Collys K, De Bruyn H, & Cosyn J. The gingival biotype revisited: transparency of the periodontal probe through the gingival margin as a method to discriminate thin from thick gingiva. *J Clin Periodontol* 2009; 36: 428-33

13. Cook DR, Mealey BL, Verrett RG, Mills MP, Noujeim ME, & Lasho DJ, et al. Relationship between clinical periodontal biotype and labial plate thickness: an in vivo study. ***Int J Periodontics Restorative Dent*** 2011; 31: 345-54

14. AlQahtani NA, Haralur SB, AlMaqbol M, AlMufarrij AJ, Al Dera AA, & Al-Qarni M. Distribution of smile line, gingival angle and tooth shape among the Saudi Arabian subpopulation and their association with gingival biotype. ***J Int Soc Prev Community Dent*** 2016; 6(Suppl1): S53-8