

Distribution of smile line, gingival angle and tooth shape among the Saudi Arabian subpopulation and their association with gingival biotype

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Abstract

Objectives: To determine the occurrence of smile line and maxillary tooth shape in the Saudi Arabian subpopulation, and to estimate the association between these parameters with gingival biotype. **Materials and Methods:** On the fulfillment of selection criteria, total 315 patients belong to Saudi Arabian ethnic group were randomly selected. Two frontal photographs of the patients were acquired. The tooth morphology, gingival angle, and smile line classification were determined with ImageJ image analyzing software. The gingival biotype was assessed by probe transparency method. The obtained data were analyzed with SPSS 19 (IBM Corporation, New York, USA) software to determine the frequency and association between other parameters and gingival biotype. **Results:** Among the clinical parameters evaluated, the tapering tooth morphology (56.8%), thick gingival biotype (53%), and average smile line (57.5%) was more prevalent. The statistically significant association was found between thick gingival biotype and the square tooth, high smile line. The high gingival angle was associated with thin gingival biotype. **Conclusions:** The study results indicate the existence of an association between tooth shape, smile line, and gingival angle with gingival biotype.

Key words: *Gingival angle, gingival biotype, Saudi Arabia, smile line, tooth shape*

INTRODUCTION

The assessment of gingival thickness is routine in clinical practice for both epidemiological and therapeutic purposes. The Seibert and Lindhe^[1] introduced the classification of gingival biotype, as thick (flat) and thin (scaloped) biotypes. The thick biotype is resistant to trauma and often associated with good periodontal health. The periodontal outcome for thick biotype is predominantly pocket formation, whereas in the thin biotype leads to fenestration and dehiscence.^[2] Invasive and noninvasive methods are used to determine the

gingival biotype.^[3] The invasive method includes the histological examination, noninvasive evaluation comprises of the probe transparency, ultrasonic devices, and radiographs. The distribution of gingival biotype varies in any given population due to its genetically linked association. The determination of gingival phenotype is essential since it is helpful to estimate the outcome of restorative and regenerative procedures.^[4] The researchers suggest the favorable outcome of immediate implant placement in thick

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gingival biotype.^[5] The periodontal surgical procedures such as crown lengthening and flap surgeries also have a predictable outcome in thick biotype.

The smiling is a means of communication, individual's personality, and well-being are associated with an esthetic smile. The tooth shape, size, position, and associated gingival display are vital components of an esthetic smile.^[6] The excessive gingival display is an esthetic concern for both patient and dentist. The smile line is broadly categorized as high, average and low according to the visibility of tooth, and gingival tissues during the smiling.

The results of previous studies indicated the tapered tooth is more often associated with thin soft tissues with highly scalloped gingival margin.^[1] The studies to assess the gingival biotype, tooth shape, and smile line distribution and their correlation are few in dental literature, especially in Saudi Arabian population. The study results will aid in designing an accurate treatment plan and to estimate treatment outcome in restorative, esthetic, periodontal, and implant dentistry. The objective of the study was to examine the distribution of gingival biotypes, smile line, and maxillary teeth shape in the Saudi Arabian population. The study purpose also included the determining an association between gingival biotype, tooth form, and smile line.

MATERIALS AND METHODS

The Institutional Ethical Committee approval was obtained for the research study proposal. The study sample included 300 male and 15 female Saudi Arabian ethnic group participants in the age group 18–35 years. The study was conducted at, Dental clinics, King Khalid University, Abha between June and October months of 2015. The simple random sampling procedure was used to select the 315 study sample with 95% confidence interval and margin of error of about five. All the participants were provided with the explanation regarding the study, and their written consent was obtained. The exclusion criteria comprised of the subjects including pregnant or lactating mothers, history of orthodontic treatment, facial trauma, and plastic surgery. The patients with periodontal pockets more than 3 mm, presence of clinical attachment loss and medications altering the periodontal soft tissues were not included in the study. The volunteers with extensive restoration, prosthetic crowns, caries, erosion, attrition, and incomplete passive eruption were also excluded from the study.

The NIKON digital single-lens-reflex camera with the resolution of 15 megapixels and 50 mm camera body

was used in the study to acquire the photographs of the participants. Camera setting was standardized for the clinical facial photography with the focal length of 105 mm Micro-Nikkor lens, shutter speed of 1/125 s, and an aperture of f/16. The color photograph in frontal view with complete exposure of maxillary teeth with the help of retractors was obtained. The graduated periodontal probe was placed alongside the maxillary incisor, perpendicular to the occlusal plane during this photograph [Figure 1]. The second photograph was captured with the patient during a maximum smile in the nonreflective blue background [Figure 2]. The opaque white ruler was placed on the left side of the photo perpendicular to the floor. The opaque ruler and the periodontal probe were used to calibrate the scale in ImageJ analytical software (National Institutes of Health, Maryland, U.S.A). Head position for all photograph was standardized by following natural head position method by mirror method of Solow and Tallgren.^[7] An image-analyzing software ImageJ, (National Institutes of Health) was utilized to measure and analyze all the images for tooth shape, gingival angles, and smile line determination [Figure 3].

Smile line classification

The patient photograph during the forced smile was imported to the ImageJ software. The average of the tooth and gingival visibility in both central incisors were assessed to designate the individual smile line. The display of >2 mm of contiguous gingiva while smiling regarded as high smile line, while average smile line was with a display of 75–100% clinical crown height. The subject with a display of <75% maxillary central incisor clinical crown height was considered as low smile line^[6,8] [Figure 4].

Tooth shape evaluation

The distance between most apical portions of the tooth to the incisal edge of the tooth was measured along the

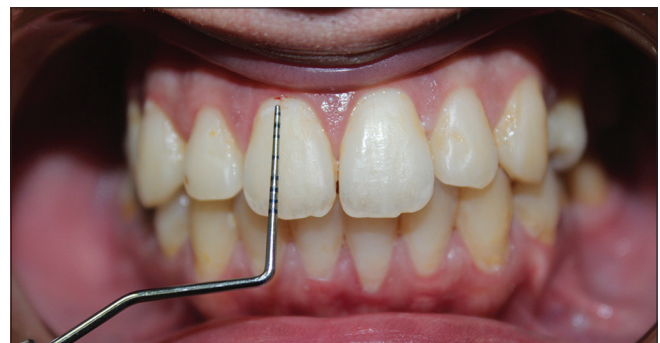


Figure 1: Intraoral photograph with periodontal probe for tooth dimension calibration

long axis to determine the crown length (CL). The contact surface area (CS) was determined by measuring the most apical portion of contact area to the most incisal portion on the mesial surface. The CS/CL ratio determined the tooth shape. The ratio <43% were

categorized as triangular, the ratio ranging between 43% and 57% were considered as tapered, and the ratio >57% were defined as square shaped tooth.^[9]

Gingival angle

It was ascertained by the determining the angle at the intersection of the line drawn from most apical portion of labial gingival margin to the apical position of mesial and distal contact points.

Gingival biotype

The gingival biotype was classified into thick and thin biotype. In the study, probe transparency (TRAN) was used to determine the gingival biotype. The gingival biotype examination was conducted by the single researchers under the supervision of lead author to eliminate the inter-examiner bias.

Statistical analysis

The data collected was analyzed with SPSS 19 (IBM Corporation, New York, USA) software with Pearson test and logistic regression for correlation and association.

RESULTS

Table 1 displays the frequency and percentage distribution of various categories of gingival biotype, smile line, and tooth shape in the investigated Saudi Arabian subpopulation. The thick gingival biotype was observed in 53% ($n = 167$) subjects in comparison with the 47% ($n = 148$) of thin gingival biotype. Among the studied population, the tapering tooth shape was observed in 56.8% ($n = 179$) subjects, followed by square shaped teeth in 91% ($n = 91$) and triangular tooth shape in 14.3% ($n = 45$) participants. The average smile category was noticed in 57.5% ($n = 181$) subjects

Table 1: Distribution of gingival biotype, smile line, and tooth shape among the population

Variable	Frequency	Percentage
Gingival biotype		
Thick	167	53
Thin	148	47
Tooth shape		
Triangular	45	14.3
Tapering	179	56.8
Square	91	28.9
Smile line		
High	76	24.1
Average	181	57.5
Low	58	18.4



Figure 2: Photograph of forced smile with scale in background

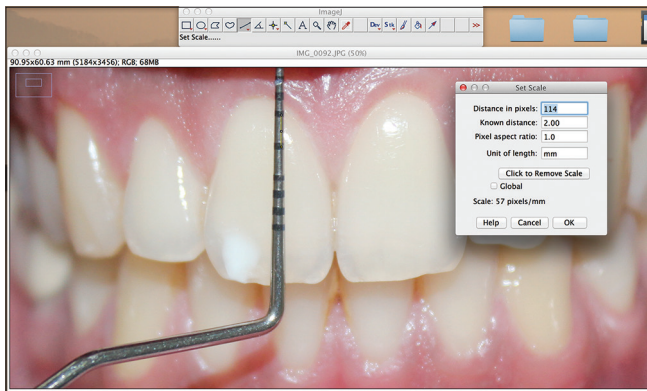


Figure 3: Tooth measurement procedure in ImageJ Software

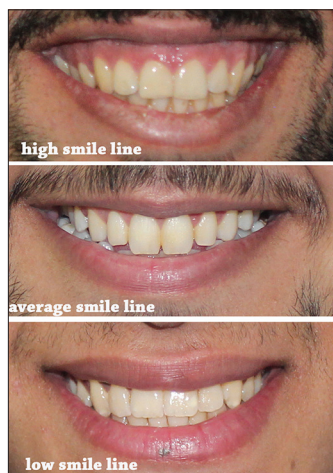


Figure 4: Photograph showing the different categories of smile line classification

in comparison with high smile line in 24.1% ($n = 76$) and low smile line with 18.4% ($n = 58$) subjects.

The Pearson correlation analysis [Table 2] indicated the gingival biotype had a strong, statistically significant correlation with tooth shape with $r = 0.294$ and $P = 0.000$. The similar statistically significant correlation was found between gingival biotype and gingival angle with $r = 0.386$ and $P = 0.000$. The smile line also had a significant correlation with gingival biotype with the $P = 0.030$ and $r = 0.122$.

The logistic regression [Table 3] model indicated the triangular tooth shape had negative b value (-1.582)

with $P = 0.000$ indicating its association with thin gingival biotype. The square tooth shape had the strong odd ratio (OR) of 2.786, $b = 1.024$, and the $P = 0.000$ indicating an association with thick biotype. The tapering tooth shape showed no statistically significant association with $P = 0.665$ and a $b = 0.099$. The high smile line recorded the $b = 0.621$, OR at 1.816 and $P = 0.023$ indicating the association with thick gingival biotype. The average and low smile had no significant association with gingival biotype with $P = 0.258$ and 0.276, respectively. The gingival angle showed the negative $b = -0.119$, $P = 0.000$ indicated the strong association with gingival biotype. The increased gingival angle showed to be correlated with thin gingival biotype.

Table 2: Matrix of Pearson correlation between tooth shape, gingival angle, smile line, and gingival biotype

	Correlations			
	Tooth shape	Gingival angle	Smile line class	Biotype
Tooth shape				
Pearson correlation	1	0.669**	-0.140*	-0.294**
Significant (two-tailed)		0.000	0.013	0.000
n	315	315	315	315
Gingival angle				
Pearson correlation	0.669**	1	-0.115*	-0.386**
Significant (two-tailed)	0.000		0.041	0.000
n	315	315	315	315
Smile line class				
Pearson correlation	-0.140*	-0.115*	1	0.122*
Significant (two-tailed)	0.013	0.041		0.030
n	315	315	315	315
Biotype				
Pearson correlation	-0.294**	-0.386**	0.122*	1
Significant (two-tailed)	0.000	0.000	0.030	
n	315	315	315	315

**Correlation is significant at the 0.01 level (two-tailed), *Correlation is significant at the 0.05 level (two-tailed)

Table 3: Multivariable logistic regression analysis assessing the association of gingival biotype with smile line, gingival angle, and tooth shape

	b	OR	95% CI	P
Tooth shape triangular	-1.582	0.206	0.098-0.432	0.000
Tooth shape tapering	-0.099	0.906	0.579-1.417	0.665
Tooth shape square	1.024	2.785	1.654-4.688	0.000
Smile line high	0.621	1.861	1.091-3.174	0.023
Smile line average	-0.259	0.772	0.492-1.209	0.258
Smile line low	-0.318	0.728	0.411-1.289	0.276
Gingival angle	-0.119	0.888	0.856-0.921	0.000

OR=Odd ratio, CI=Confidence interval

DISCUSSION

The esthetic concern though exists from the early civilization, but the demand for ideal dental esthetic rehabilitation is on a rise in contemporary dentistry. The researchers suggest the classification of tooth shape as triangular, ovoid (tapering), and triangular. The results of the study are in agreement with the finding of Paranhos *et al.*^[10] They reported the most common tooth shape is tapering (47.06%), and least was triangular morphology with 21.57%. This study also found the similar pattern with the highest number of tapering teeth with 56.8% followed by square (28.9%) and triangular (14.3%) morphology. The difference in the results in various ethnic groups could be due to the strong genetic and hereditary link to teeth morphology.^[11] The knowledge of prevalent tooth shape in the local population helps the dentist in choosing tooth for the prosthesis and cosmetic modification of tooth morphology during esthetic rehabilitation.

The identification of gingival biotype is necessary to design treatment plan and assessing treatment outcome. The probe transparency (TRAN) method was found to be reliable from an earlier researchers observations with 85% inter-examiner repeatability.^[12] The majority of the studies reported the thick biotype is most widespread in the general population. The study conducted by the Olsson and Lindhe^[13] found 85% of the subjects had the thick biotype while another study^[14] reported population with 56.75% prevalence of thick biotype. The results of the study indicated the presence of 53% of the population with thick biotype and 47% of the subjects had thin biotype. The results were similar to the results conducted on the Saudi population in the western region with 55.5% of cases with thick biotype and 44.5% subjects had thin gingival biotype.^[15] The thin biotype is known to respond poorly

to inflammation, trauma, and surgical insult due to the difference in blood supply to the alveolar bone and consequent bone resorption.

The upper lip position, curvature, parallelism of maxillary teeth incisal edge with lower lip curvature and number of the teeth displayed are essential components of a pleasant smile.^[16] According to the upper lip position and visibility of tooth, gingiva while smiling the smile line are categorized into high, average, and low smile lines. The previous studies^[17] have reported the average smile is most common and followed by high and low smile line. The results of the study are in agreement with previous study findings with 57.5% had an average smile, 24.1% had a high smile line, and 18.4% had low smile line.

The results of the study confirmed the strong correlation between tooth shape and gingival angle and gingival biotype with the $P = 0.000$. The results of the study indicated the square shaped tooth was positively associated with thick gingival biotype with OR at 2.785, and $P = 0.000$. The triangular shaped tooth showed the negative association with the $b = 1.582$ and $P = 0.000$. The earlier researchers reported^[18] the association of thick gingival biotype with square tooth shape and thin gingival biotype with the tapered tooth. The Cook *et al.*^[19] found no association between the gingival biotype and tooth morphology. The deviation in result could be attributed to variations in the research methodology.

The study revealed the high smile line had a significant association with gingival biotype with $b = 0.621$ and $P = 0.023$. The high smile with frequent exposure of gingiva may lead to thickening of gingiva due to increased keratinization and create a barrier for mechanical irritations. The results of the study also indicated the negative association of gingival angle to the gingival biotype with $b = -0.119$ and $P = 0.000$. The increased gingival angle with more scalloped gingiva was more associated with thin gingival biotype. Stellini *et al.*^[20] reports the different tooth shapes are associated with significantly different values for the extent of the keratinized mucosa, its buccolingual thickness and the height of the interproximal maxillary central papilla. The gingival margin is placed more apically in ovoid and triangle tooth with pronounced cervical convexity in comparison with square shape tooth. The proximal contact areas in tapering or triangular teeth are located near incisal edge increasing the gingival angle. Hence, scalloped thin gingiva is likely to be more associated with

scalloped, high periodontal bioform. The periodontal bioforms (gingival angle) determination is helpful for treatment planning of implant placement, the assessment of posttreatment complication of gingival recession and black triangle.

The limitation of the study included the limited sample size from one region of the Saudi Arabia. The inclusion of larger representative sample for all part of the Saudi Arabia is suggested for the confirmation of the result. The comparison of study results between the genders was not plausible due to inadequate female subjects. The additional researches among another ethnic groups are required to understand the difference in the association between tooth shape, gingival biotype, and smile line. The high smile line is routinely considered as contraindication for the immediate implant placement. The study results indicate the possibility of immediate implant placement in the high smile line patients due to the association between high lip line and thick gingival biotype. Further studies are suggested to understand the patient and observers esthetic perception regarding tooth shape selection according to prevalent tooth shape.

CONCLUSIONS

Within the limitation of the study, following conclusions were drawn. The tapering tooth morphology was most general tooth shape in the studied Saudi Arabian subpopulation with 56.8%, followed by square shape at 28.9% and triangular morphology at 14.3%. The thick gingival biotype was seen in 53% of subjects, and 47% of the population had thin gingival biotype. The average smile line was most frequent with 57.5%, and high smile line was recorded in 24.1%, low smile line in 18.4%. The statistically significant association was found between square tooth shape and thick gingival biotype while triangular tooth shape was related with thin gingival biotype. The high smile line was observed to be allied with thin gingival biotype.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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