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ORIGINAL ARTICLE

Facial profile based evaluation of gingival zenith position in maxillary central incisors among Saudi, Indian & Bangladeshi population

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KEYWORDS

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Abstract *Background:* Recently quantitative evaluation of gingival zenith position was evaluated in different facial forms suggesting clinicians may need to evaluate patients facial form and then decide to distalise the Gingival Zenith position in relation to Vertical Bisected Midline (VBM). The aim of the study was to quantitatively evaluate the gingival zenith width in convex, concave and straight facial profiles for Saudi, Indian and Bangladeshi nationals.

Materials/methods: 114 subjects of each Saudi, Indian & Bangladeshi nationality were grouped into convex, concave and straight profile based on angle of convexity. Gingival zenith position (GZP) on #11 and #21 was evaluated on the scanned dental plaster model using CBCT. Inter and Intra group comparison was done using one-way ANOVA test.

Results: Mean GZP values ranged from 0.84 mm to 1.10 mm, 0.75 mm to 1.02 mm and 0.87 mm to 1.14 mm for Saudi, Indian and Bangladeshi subjects respectively. Statistically significant ($p < 0.05$) difference was observed in convex, concave and straight profile subjects of these nationalities.

Conclusion: GZP variation does exist in different facial profiles of Saudi, Indian & Bangladeshi nationalities with respect to central incisors.

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Clinical significance: These findings help clinician to consider facial profile as important entity in designing the smile following restorative and prosthetic procedures such as crown lengthening, teeth selection, implant esthetics and laminates.

1. Introduction

To design a perfect smile various factors such as form of face, tooth and dento-gingival complex/gingiva are of paramount importance. Extensive research is being carried out regarding facial form and tooth form in designing a perfect smile as a standard protocol while restoring the structure, morphology and function of a maxillary anterior segment (Ahmad, 1998; Chu et al., 2009). Recently gingival morphology is being considered as an important factor in crafting the smile design. In this regard reports suggested that facial form, tooth form and gingival morphology are the parameters from the frontal perspective (Chu et al., 2009; Ahmad, 2005, 1998). From the literature it is also evident that Gingival zenith plays an pivotal role in esthetics. Gingival zenith is the most apical aspect of the free gingival margin (FGM). Its location was found to be distal to the vertical bisected midline (VBM) for central incisor and lateral incisor and for canine it is supposed to coincide with the VBM (Chu et al., 2009). However, different studies have yielded various results regarding its location with respect to VBM of the maxillary anterior teeth and leaves a lot to be desired (Núbia Inocencya Pavesi Pini et al., 2012). Recently quantitative evaluation of gingival zenith position was evaluated in different facial forms suggesting clinicians may need to evaluate patients facial form and then decide to distalise the Gingival Zenith position in relation to VBM (Bhatsange et al., 2015). Whether facial profiles decide the shape of teeth and gingival zenith position is not known. Therefore, the present study was undertaken with an aim to quantitatively evaluate the gingival zenith width in convex, concave and straight facial profiles for Saudi, Indian and Bangladeshi nationals.

2. Materials and methods

This cross-sectional study was carried out in patients attending College of Dentistry, Aljouf University Sakaka, KSA among Saudi, Indians & Bangladeshi subjects, after obtaining approval from the institutional ethical committee from January 2017 to June 2017.

2.1. Study population and characteristics

All participants provide their written informed consent prior to the study which was designed and conducted according to the guidelines of Strengthening the Reporting of Observational studies in Epidemiology (STROBE), and we applied the STROBE checklist in the preparation of this manuscript (von Elm et al., 2014). Based on mean values and standard deviation obtained from literature review the effect size of gingival zenith position was calculated. The study subjects were selected from the archive of Radiology department, using simple random technique until desired sample size was achieved. The subjects were selected based on the inclusion criteria such as healthy gingival status, absence of gingival recession or gingival hypertrophy, tooth without loss of interdental papillae, absence of any type of tooth deformity due to trauma or any other cause or any malocclusion including rotation, tipping proclination and spacing. Exclusion criteria included history of any gingival surgical treatment for aesthetic or elimination of periodontal problems. The effect size obtained was used to determine the study population for each nationality using G-power computing tool with minimum of 36 subjects were needed in each group. Hence, a sample size of 114 male subjects for each nationality were selected as study samples for the study with age ranging from 20 to 30 years. The subjects were further divided into 3 groups based on their profile such as Group A – Convex profile, Group B – Concave profile and Group C – straight profile.

2.2. Facial profile determination

The facial profile was determined by two step verification method. Method 1 (Initial): Clinical evaluation of the facial profile was done using two soft tissue points. Point A: Philtrum. (Deepest point of philtrum). Point B: Pogonion. (Highest point on the contour of the chin). Depending upon the alignment of the 2 points, the profile can be (A) Straight profile: When all the 2 points lie in the same vertical, the profile is said to be straight. (B) Convex profile: It the point A is ahead or the pogonion point is placed behind, then the profile said to be convex, (C) Concave profile: If the A point is placed behind or the pogonion is placed forward, the profile is said to be concave (Alam, 2012). Method 2 (Confirmatory): After segregating the patients in convex, straight and concave profile as per method 1 final confirmation of samples facial profile is achieved based on angle of convexity (Kulkarni et al., 2012, Mohammad Khursheed Alam et al., 2012) using following criteria:

1. For convex profile the angle of convexity was considered as positive and increased with is >4.5.
2. For straight profile the angle of convexity was considered as average and ranging from 0 to 4.5
3. For concave profile the angle of convexity was considered as negative and decreased <0.

2.3. Measurement of gingival zenith position (GZP)

Alginate impression were made and diagnostic casts were prepared with dental stone. An electronic calibrated digital caliper was used to measure the gingival zenith width on maxillary central incisors (#11, #21). To mark the VBM of each clinical crown, the width of the crown was measured at 2 points, one at

Fig. 1 Measurement of GZP from VBM using digital calibrated caliper.

the proximal incisal contact area position and other at apical contact area position which was considered as reference point. Centre of each width was marked and a line was drawn to connect the centers. This line was prolonged toward the gingival aspect of the clinical crown to define VBM. The highest point on the free gingival margin was marked. Subsequently, the distance between the VBM and the highest point in the gingival margin was measured in both maxillary central incisors to obtain the GZP in a medio-lateral direction (Fig. 1).

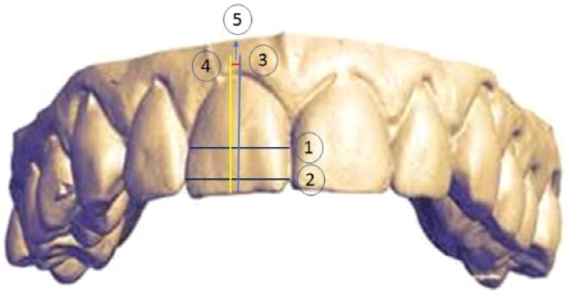

Fig. 2 Measurement of GZP from scanned dental plaster images using CBCT. 1- Presents the horizontal line at apical contact point. 2- Presents the horizontal line at incisal contact point. 3- Vertical line extending till gingival margin joining the centre point of two horizontal line at contact point. 4- GZP located at apical most gingival part of gingival margin.5. Measurement of GZP from VBM.

2.4. 3D evaluation of GZP using cone beam computed tomography

Digital models were scanned from the same plaster models of the samples using the Cranex^{TM} 3Dx device (Soredex, Tuusula, Finland). All scans were performed at 96 kV and 11.0 mA for 12 s (voxel size: 200 lm; gray scale: 15 bits; focal spot: 0.5 mm; and field of view: 100 × 955 mm). Image reconstruction for visual analysis of GZP was estimated after obtaining VBM on the scanned digital models was performed using the OnDemand 3D software package (Cybermed, Inc, Seoul, Korea) (see Fig. 2).

2.5. Training and calibration of investigators

Two trained examiner recorded the GPZ scores and intra examiner kappa score for KKG and MK was 0.84 and 0.96 respectively and inter examiner agreement was almost perfect.

2.6. Statistical Analysis

Statistical analysis was done using statistical package for social sciences (SPSS) version 24 (IBM. Inc, Chicago). Descriptive statistics was done to describe various parameters and mean width of gingival zenith position in convex, concave and straight profiles. Inter-group and intra-group comparisons were done using ANOVA test. A p-value of ≤ 0.05 was considered statistically significant. Post-hoc intra-group comparisons were analyzed using Scheffe Test.

3. Results

For convex profile of Saudi subjects the mean distance of GZP and VBM of #21 was higher than #11, where as in case of concave profile the mean distance of GZP and VBM of #11 was higher than #21. Statistically significant difference was estimated upon comparison of GZP in different facial profiles (Table 1). In Indian subjects the mean distance of GZP and VBM of #21 was higher than #11 for convex profile, where as in case of concave profile and straight profile the mean distance of GZP and VBM of #21 was higher than #11. Statistically significant difference was estimated upon comparison of GZP in different facial profiles (Table 2). For Bangladeshi subjects the mean distance of GZP and VBM of #21 was higher than #11 in case of convex and concave profile where as in

Table 1 Comparison of mean gingival zenith position (GZP) in relation to vertical bisected line (VBM) of maxillary tooth in different facial profiles of Saudi subjects (n = 114).

GZP	N	Mean (mm)	ANOVA	
			F	p-value
Convex #11	37	.84(±.08)	14.480	0.00*
Convex #21		.91(±.08)		
Concave #11	39	1.10(±.14)		
Concave #21		.95(±.23)		
Straight #11	38	.86(±.08)		
Straight #21		.90(±.07)		

* $p < 0.01$.

Table 2 Comparison of mean gingival zenith position (GZP) in relation to vertical bisected line (VBM) of maxillary tooth in different facial profiles of Indian subjects (n = 114).

GZP	N	Mean (mm)	ANOVA	
			F	*p*-value
Convex #11 (n = 38)	38	.75(±.065)	13.543	0.00*
Convex #21 (n = 38)		.84(±.542)		
Concave #11 (n = 37)	37	.97(±.875)		
Concave #21 (n = 37)		1.02(±.432)		
Straight #11 (n = 39)	39	.89(±.763)		
Straight #21 (n = 39)		.97(±.983)		

* $p < 0.01$.

Table 3 Comparison of mean gingival zenith position (GZP) in relation to vertical bisected line (VBM) of maxillary tooth in different facial profiles of Bangladeshi subjects (n = 114).

GZP	N	Mean (mm)	ANOVA	
			F	*p*-value
Convex #11 (n = 39)	39	.87(±.358)	14.195	0.00*
Convex #21 (n = 39)		1.14(±.089)		
Concave #11 (n = 36)	36	0.98(±.573)		
Concave #21 (n = 36)		1.05(±.836)		
Straight #11 (n = 39)	39	0.98(±.258)		
Straight #21 (n = 39)		0.89(±.687)		

* $p < 0.01$.

Table 4 Comparison of mean gingival zenith position (GZP) in relation to vertical bisected line (VBM) of maxillary tooth among different nationalities (n = 342).

Different nationality	N	Mean (mm)	ANOVA	
			F	*p*-value
Saudi	114	.95(±.47)	.829	.455
Indian	114	.90(±.40)		
Bangladeshi	114	.98(±.41)		

straight profile the mean distance of GZP and VBM was higher in #11 than #21. Statistically significant difference was estimated upon comparison of GZP in different facial profiles (Table 3). Upon comparison for mean distance of GZP among different nationalities no statistical significant difference was noticed (Table 4).

4. Discussion

GZP is the most apical part of gingival margin which significantly influence the esthetics. Before any type of esthetic treatment, the esthetic evaluation always starts with the smile analysis. Correct spatial positioning of the zenith following therapeutic manipulation is mandatory, because it can greatly influence the emergence profile and axial inclination of the teeth by modifying the line angle position of the long axis of the emergence of the crown from the gingiva and thus, add the proper symmetry to the entire soft tissue system (Mattos and Santana, 2008, Dipti Shah, 2014). Understanding the dento-gingival interface will allow clinician to achieve a more satisfactory esthetic outcome during interdisciplinary diagnosis and treatment. Dental esthetics is not all about the white esthetics i.e. tooth, but pink esthetics i.e. gingiva also is of indispensable importance, as both are incomplete if not in harmony. The literature primarily consists of conjecture and has a presented differing information on where the GZP is located form the VBM of each maxillary anterior teeth (Fradeani and Barducci, 2004). Along with the other constraints related to dental esthetics, these clinical parameters may oblige as esthetic guidelines and may enable us to obtain a more predictable outcome (Pawar et al., 2011). The influence on the beauty of smile from an irregular gingival contour height can be dramatic and although the position of the zenith of the gingival tissue seems like a small detail, it can greatly influence the axial inclination and emergence profile of the teeth. Mattos quantitatively evaluated spatial displacement of gingival zenith in the maxillary anterior dentition and proposed that gingival zenith is not universally displaced to distal aspect and the frequency and magnitude of such distal displacement was found to be larger in central incisor, than in lateral which in turn is

larger than canine (Mattos and Santana, 2008). Goodlin reported that the deviation of GZP from VBM was 1 mm in central incisors and 0.4 mm in lateral incisors (Goodlin, 2003). The findings reported in the present study are in consistent with the findings of Zagar who proposed that the frequency and magnitude of distal displacement in gingival zenith of is tooth-dependent and larger in central incisor than in lateral incisor and which is still greater in canines (Žagar et al., 2010; Chu et al., 2009). With regards to sample size the present study depicts results originating from the high samples. The methodology employed in the study is of unique kind as two step verification of each method is used to prevent intra-procedure error at the same time each gold standard procedure (Trentini et al., 1995) is verified by and alternative advanced procedural technique. Till date as per literature review no study was conducted to analyze the GZP in different facial profiles and nationality. In the present study an attempt was made to evaluate the difference between GZP in relation to VBM in different facial profiles such as convex, concave and straight among population representative of different nationality There are statistically significant difference of GZP in relation to VBM between convex, concave and straight profile with respect to #11 and #21. These findings are in consistent with study done by Babita who proposed that a directional asymmetry was shown with the right side higher than the left side. The outcome of the present study is in accordance with the findings of the study done by Bhatsange et al. (2015). This study quantitative evaluated gingival zenith position of maxillary central incisors in different facial forms which was statistically significant in relation to VBM within four face types (Bhatsange et al., 2015). The outcome of the present study suggests that variation of GZP occurs with respect to change in profile. Possible reasons for such variation could be changes in gingival morphology following skeletal or dental abnormalities. Gowd et al. propose that the degree of proclination of maxillary anterior dentition was correlated to the gingival contour in bimaxillary cases (Snigdha Gowd et al., 2017). This investigation also revealed that there is a variation in the location of GZP as the severity of proclination increases. Findings from the present study are in accordance with Gowd et al. study (Snigdha Gowd et al., 2017) to provide evidence as profile changes is associated with proclination of dentition which is directly related to GZP variations. Multiple contra-lateral comparisons among different nationalities revealed that no significant difference in GZP among convex, concave and straight profiles suggesting bilateral symmetry in case of #11 and #21. This study provided us an prospect to assess the esthetic principle and its deportment in interdisciplinary esthetic rehabilitation These findings helps the clinician to generalize the fact the variations in GZP is limited to different profile patterns but no such variations exists among the subjects of different nationality. The prevalence of malocclusion varies from one geographical area to another and differs from one country to another and even from one city to another. Different studies on different geographical locations have yielded different prevalence rate of malocclusion (R., 2001, WR, 2000). To rationalize such issue of geographical variation of malocclusion only Asian subjects of different nationality were selected in the present study. The present was conducted in males subjects only which is one of the major limitation as depicted. This pattern of study design is developed based on the comparative study by Charruel reported that no significant difference was found between male and female for the GZP of right and left central incisors suggesting the no gender variation (Charruel et al., 2008). Another recent study supports the finding that no significant difference was found between male and female for the gingival zenith level of right and left lateral incisors (Humagain et al., 2016).

The novelty of the current study stands upon the following points: (1) 450 CBCT data; (2) Three different races data; (3) assessment of GZP using new approach in confirmation with the traditional method. This study assessed the overall variations of GZP in different facial profiles with respect to different nationality which is imperious for providing valuable information for the field of esthetic dentistry.

Conclusion: Gingival zenith position is not uniformly displaced towards distal aspect in different facial profiles. Facial profile that influence gingival zenith position should be considered as an important entity in designing the smile following restorative and prosthetic procedures. Such considerations help during treatment planning of smile design in procedures involving crown lengthening, teeth selection, implant esthetics and laminates.

5. Clinical significance

Interdisciplinary approach of orthodontist, periodontist and prosthodontist is essential in the multidisciplinary team for the treatment of patients with esthetic and functional rehabilitation, as these procedures are necessary to restore the shape and proportionality of the smile which is now an integral part of patient satisfaction. The GZP finding obtained from this study can be clinically applied to reestablish the GZP of the maxillary anterior teeth during periodontal surgery; crown lengthening or root coverage procedures, prosthetic designing of the crown contours and orthodontic smile design.

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Authorship/researcher contribution

1. Conception and design of the work: KKG, MKA.
2. Acquisition of data, or analysis and interpretation of data: KKG, MKA, AFA.
3. Drafting the article or revising it critically for important intellectual content: KKG, MKA.
4. Final approval of the version to be published: KKG, MKA, AFA.

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Conflict of interest

Authors hereby declare that there is no conflict of interest.

References

Ahmad, I., 1998. Geometric considerations in anterior dental aesthetics: restorative principles. Practical periodontics and aesthetic dentistry: PPAD, 10, 813-22; quiz 824.

Ahmad, I., 2005. Anterior dental aesthetics: Gingival perspective. Br. Dent. J. 199, 195–202.

Alam, M.K., 2012. A to Z Orthodontics. PPSP Publication, Malaysia.

Bhatsange, A., Mehetre, V., Waghmare, A., Kerudi, L., Ahire, A., Shende, A., 2015. A quantitative evaluation of gingival zenith position of maxillary central incisors in different facial forms. IOSR J. Dent. Med. Sci. (IOSR–JDMS) 14, 62–65.

Charruel, S., Perez, C., Foti, B., Camps, J., Monnet-Corti, V., 2008. Gingival contour assessment: clinical parameters useful for esthetic diagnosis and treatment. J. Periodontol. 79, 795–801.

Chu, S.J., Tan, J.H.P., Stappert, C.F., Tarnow, D.P., 2009. Gingival zenith positions and levels of the maxillary anterior dentition. J. Esthetic Restorative Dentistry 21, 113–120.

Dipti Shah, K.V., Duseja, Sareen, Agrawal, Pankti, 2014. Relative position of gingival zenith in maxillary anterior teeth- a clinical appraisal. Int. J. Healthcare Biomed. Res. 3, 77–81.

Fradeani, M., Barducci, G., 2004. Esthetic Rehabilitation in Fixed Prosthodontics, Volume 2.

Goodlin, R., 2003. COSMETIC DENTISTRY-gingival aesthetics–a critical factor in smile design. Oral Health 93, 10–28.

Humagain, M.R.D., Srii, R., Dixit, S., Kafle, D., 2016. Gender based comparison of gingival zenith esthetics. Kathmandu Univ. Med. J. 54, 148–152.

Kulkarni, N., Vasudevan, S., Shah, R., Rao, P., Balappanavar, A., 2012. Cheiloscopy: A new role as a marker of sagittal jaw relation. J. Forensic Dent. Sci. 4, 6–12.

Mattos, C.M., Santana, R.B., 2008. A quantitative evaluation of the spatial displacement of the gingival zenith in the maxillary anterior dentition. J. Periodontol. 79, 1880–1885.

Alam, Mohammad Khursheed, Basri, Rehana, Kathiravan Purmal, M.A., Sikder, Mohammed Saifuddin, Iida, J., 2012. A soft tissue cephalometric analysis for bangladeshi adult using Holdway's analysis. Int. Med. J. 19, 333–336.

Núbia Inocencya Pavesi Pini, L.M.D.-M., Ramos, Adilson Luiz, Furquim, Laurindo Zanco, Gribel, Bruno Frazão, Pascotto, Renata Corrêa, 2012. Analysis of width/height ratio and gingival zenith in patients with bilateral agenesis of maxillary lateral incisor. Dental Press J. Orthod. 17, 87–93.

Pawar, B., Mishra, P., Banga, P., Marawar, P., 2011. Gingival zenith and its role in redefining esthetics: A clinical study. J. Indian Soc. Periodontol. 15, 135.

R.S.N., 2001. Etiology and Prevalence of Malocclusion, Philadelphia, Saunders.

Snigdha Gowd, T.S., Chatterjee, Suravi, Mohanty, Pritam, Sahoo, Nivedita, Baratam, Srinivas, 2017. Gingival zenith positions and gingival zenith levels of maxillary anterior dentition in cases of bimaxillary protrusion: a morphometric analysis. J. Contemp. Dent. Pract. 18, 1–5.

Trentini, C.M., Moriarty, J.D., Phillips, C., Tulloch, J.F., 1995. Evaluation of the use of orthodontic records to measure the width of keratinized tissue. J. Periodontol. 66, 438–442.

Von Elm, E., Altman, D.G., Egger, M., Pocock, S.J., Gøtzsche, P.C., Vandenbroucke, J.P., 2014. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. Int. J. Surg. 12, 1495–1499.

Wr, P., 2000. Malocclusion and Dentofacial Deformity in Contemporary Society. Contemporary Orthodontics, Missouri, Mosby.

Žagar, M., Knezović Zlatarić, D., Carek, V., 2010. A quantitative evaluation of the distal displacement of the gingival zenith in the maxillary anterior teeth. Collegium Antropologicum 34, 225–228.