

Comparative Evaluation of Gingival Zenith Deviation from the Vertical Bisected Midline and Apicocoronal Displacement of the Zenith of Lateral Incisor From Gingival Zenith Level: A Cross-sectional Study

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ABSTRACT

Aim and objective: To measure the deviation of the gingival zenith (GZ) of maxillary anterior teeth with the vertical bisected midline (VBM) and apicocoronal displacement of lateral incisor zenith from GZ level of central incisor and canine.

Materials and methods: For 50 periodontally healthy subjects (age range 18–50 years) having all anterior teeth, alginate impressions were made and a diagnostic cast was obtained. Gingival zenith was marked and its deviation from the VBM was measured for the maxillary anterior teeth using the method described by Chu and Stappert. The apicocoronal distance of the GZ point of the lateral incisor was measured from the GZ level of the central incisor and canine. The data were tabulated and subjected to statistical analysis.

Results: Gingival zenith deviation was greater in the central incisor, followed by lateral incisor and canine. The mean apicocoronal displacement of the GZ of the right lateral incisor was 0.606 ± 0.417 mm and the left lateral incisor was 0.537 ± 0.414 mm from the GZ level.

Conclusion: Gingival zenith deviation can be mesial or distal and is tooth-dependent. It was found that in the majority of cases, lateral incisors showed coronal displacement of GZ from the GZ line.

Clinical significance: Gingival zenith and its deviation play a major role in esthetic dentistry. Therefore, understanding the GZ deviation seen in the population will enable the clinician to make an evidence-based treatment for the patient.

Keywords: Gingival zenith, Gingival zenith deviation, Gingival zenith line, Maxillary anterior teeth, Vertical bisected midline.

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INTRODUCTION

Multidisciplinary integration is necessary to achieve esthetical and functional results in simple and complex dental rehabilitation. Planning and establishing the correct timing of the involved procedures increase treatment predictability. While performing the oral rehabilitation procedures, either we can mimic the contralateral teeth form, alignment, and proportion or design it based on the esthetic principles and characteristics of individual teeth. Designing a harmonious smile would require interventions from individual dental specialties, such as surgical, orthodontic, and restorative procedures. To substantiate the necessity of such interventions, the gingival contour must be evaluated, and establishing the correct gingival zenith (GZ) aids in the treatment planning as well as in the following dental procedures.¹

Gingival zenith is the most apical portion of the gingival margin. Studies have shown that in maxillary central incisors, it is usually distally displaced and in maxillary lateral incisors and canines, it is usually centralized.¹

The GZ plays a pivotal role in the case of cosmetic dentistry. The form and contour of gingival tissues along with the overall esthetics form the important factors that define an esthetic smile. The visibility of the dentogingival interface in the anterior region thus pose an esthetic challenge to dental procedures in this region. The physiologic gingival contour has been defined as the one in which the interdental area is conical and coronally positioned to the buccal and lingual (or palatal) plates of bone, which have a parabolic shape and flow smoothly from the interdental area; that

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follows the shape of the cemento-enamel junction (CEJ), allowing a thin, scalloped, knife-edged gingival contour with pyramid-shaped papillae that fill the interproximal space. This knife-edged, festooned marginal gingival contour is primarily affected by the degree of concavity and convexity of the tooth surface.²

It is very important to locate the gingival zenith point (GZP) especially when carrying out esthetically important procedures such as changing mesiodistal dimensions or in cases of diastema closure. Also, while trying to reduce the exaggerated triangular form of teeth or bringing about the illusion of bodily movement by altering the position of the GZ, or for correction of tooth angulation, locating the GZ is very important.³

The contour of gingival margins, along with the smile and facial components must all be in harmony therefore any deviations must be corrected by surgical or orthodontic treatment especially when the patient presents a high lip line.

Thus the study aimed to measure the deviation of GZ of maxillary anterior teeth from the vertical bisected midline (VBM) and also to measure the GZ distance (apicocoronally) of lateral incisor from gingival zenith level (GZL) of central incisor and canine.

MATERIALS AND METHODS

Patients presenting to the Department of Periodontics and Oral Implantology, AME's Dental College and Hospital, Raichur, Karnataka, India fulfilling the inclusion and exclusion criteria were enrolled in the study. The study was explained to the patient and written informed consent was taken and an ethical clearance certificate was also obtained from the institution.

The inclusion criteria included periodontally healthy subjects of 18 years and above, having all six maxillary anterior teeth. The exclusion criteria included subjects having crown restoration or prosthesis in maxillary anterior teeth, those with spacing, crowding, or midline diastema, those receiving medications with any known effect on periodontal soft tissue, those undergoing orthodontic treatment or with the previous history of orthodontic treatment, and those with any history of periodontal surgery in the maxillary anterior region. Thus, 50 periodontally healthy subjects (45 females, 5 males) were included in the study.

Alginate impressions were made and poured with dental stone and a diagnostic cast was obtained for each subject. On each cast, the following points were marked, i.e., VBM, GZP, and GZL. All the measurements were done using a digital caliper.

The GZP and VBM was marked according to the method given by Chu et al. in 2009.⁴ Vertical bisected midline was marked for each tooth from canine to canine using the following method. The mesiodistal width of the tooth was measured at two reference points. The two reference points taken were the proximal incisal contact area position (ICAP) and the apical contact area position (ACAP) (Fig. 1). Both the widths were divided in half, and the center point for each was marked. The two center points were then further extended toward the gingival contour of the crown to obtain a line and thus the VBM was located (Fig. 2).

The highest point of the gingival contour for each tooth gives the GZP. Thus, the GZP was identified and marked for all six maxillary

anterior teeth (Fig. 1). The distance of the GZP to the VBM was measured with a digital caliper for each tooth, including the central incisors, lateral incisors, and canine teeth (Fig. 3).

A gingival line (tangent) was drawn by joining the GZP of the maxillary central to the canines to obtain GZL. The distance of the GZP of the lateral incisor was measured from the GZL in an apicocoronal direction. This was then compared with the GZL of central incisor and canine (Fig. 4).

The data obtained were tabulated and subjected to statistical analysis using the software (SPSS version 20, IBM Corp., Armonk, NY, USA). The data obtained were statistically analyzed using a repeated *T* test.

RESULTS

Fifty casts were evaluated for deviation of GZ of all the maxillary anterior teeth from the VBM. Both mesial and distal deviations were seen, although the majority showed distal deviation. The apicocoronal displacement of GZ of lateral incisor from the GZL of central incisors and canine was also evaluated.

Table 1 shows the deviation of GZP from the VBM of central incisors, it was found that in 74% of right central incisors (37 out of 50, mesial deviation-12, distal deviation-25) and 68% of left central incisors (34 out of 50, mesial deviation-4, distal deviation-30), the GZ showed deviation. The mean deviation was 0.307 ± 0.605 mm for right central incisors and 0.229 ± 0.258 mm for left central incisors. The difference in the mean GZ deviation from VBM between right and left central incisors was not statistically significant (*p* value = 0.345).

In the case of lateral incisors, Table 1 shows that in 64% of right lateral incisors (32 out of 50, mesial deviation-18, distal deviation-24) and 78% of left lateral incisors (39 out of 50, mesial deviation-3, distal deviation-36), the GZP showed deviation from the VBM. The mean deviation was 0.159 ± 0.194 mm for right lateral incisors and 0.276 ± 0.265 mm for left lateral incisors. The difference in the mean GZ deviation from VBM between right and left lateral incisors showed a highly statistically significant variation (*p* value = 0.005).

Table 1 shows the deviation of GZ point from the VBM of canine and it was found that in 66% of right canines (33 out of 50, mesial deviation-19, distal deviation-14) and 50% of left canines (25 out of 50, mesial deviation-6, distal deviation-19), the GZ showed deviation. The mean deviation was 0.173 ± 0.234 mm for right



Fig. 1: Marking of gingival zenith and two reference points (proximal incisal contact area position and the apical contact area position)



Fig. 2: Location of vertical bisected midline using the reference points



Fig. 3: Measurement of variation of gingival zenith from vertical bisected midline using Vernier caliper



Fig. 4: Measurement of variation of gingival zenith of lateral incisor from gingival zenith level using Vernier caliper

Table 1: Mean deviation of gingival zenith point of the individual tooth from vertical bisected midline

Tooth no.	No. of teeth showing deviation (out of 50)	Mean \pm SD	<i>p</i> value	Standard error mean	Mean difference	Standard error difference	95% confidence interval	
11	37	0.307 \pm 0.605	0.345	0.07573	0.07812	0.08234	U	L
21	34	0.229 \pm 0.258		0.03233			-0.08	-0.24
12	32	0.159 \pm 0.194	0.005	0.02437	-0.11719	0.0412	U	L
22	39	0.276 \pm 0.265		0.03324			-0.19	-0.03
13	33	0.173 \pm 0.234	0.625	0.02931	-0.02187	0.04464	U	L
23	25	0.195 \pm 0.269		0.03366			-0.11	0.06

SD, standard deviation. *p* value \leq 0.05

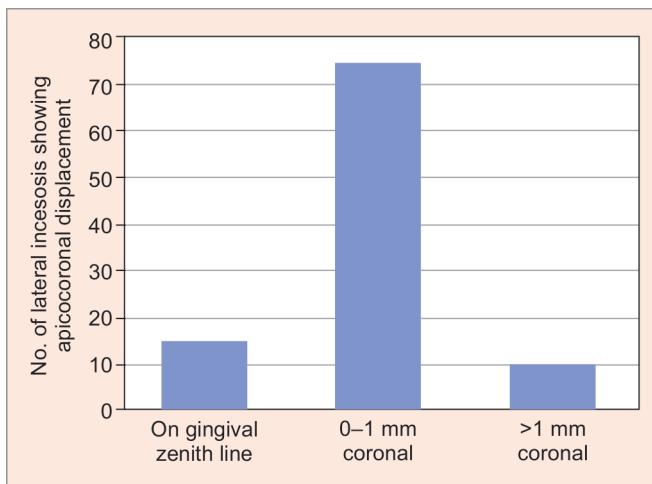


Fig. 5: Apicocoronal displacement of gingival zenith point of lateral incisor from gingival zenith level

canines and 0.195 ± 0.269 mm for left canines. The difference in the mean GZ deviation from VBM between right and left canine was not statistically significant (*p* value = 0.625).

Figure 5 shows apicocoronal displacement of GZP of the lateral incisor from the GZL. In the majority of cases (75%), GZP was displaced in the range of 0 to 1 mm and in 10% of cases GZP was displaced >1 mm from the GZL and in around 15% of cases, GZP coincided with the GZL.

Table 2: Mean apicocoronal displacement of lateral incisors from the gingival zenith level

Tooth number	Total number of teeth	Mean apicocoronal displacement of lateral incisor from gingival zenith level
12	50	0.606 \pm 0.417
22	50	0.537 \pm 0.414

12-Right lateral incisor, 22-Left lateral incisor

Table 2 shows the mean apicocoronal displacement of GZP of lateral incisor with respect to the GZL. The right lateral incisor showed a deviation of 0.606 ± 0.417 mm and the left lateral incisor showed a deviation of 0.537 ± 0.414 mm.

Figure 6 shows no. of teeth showing deviation of GZ from VBM in each of the maxillary anteriors. Out of 50 each, the left lateral incisor had a maximum no. of teeth showing deviation from the VBM, while the left canine had the minimum no. of teeth showing deviation from the VBM.

DISCUSSION

Healthy gingiva is among the prime requirement during esthetic treatment planning and it is important to consider its morphology and contour.⁵ To provide more satisfactory esthetic results in a complete rehabilitation involving interdisciplinary intervention; one needs to be very specific about the dentogingival interface. Gingival zenith being an important feature in gingival morphology; can lead to a negative smile effect if there is any discrepancy in GZ position.⁶

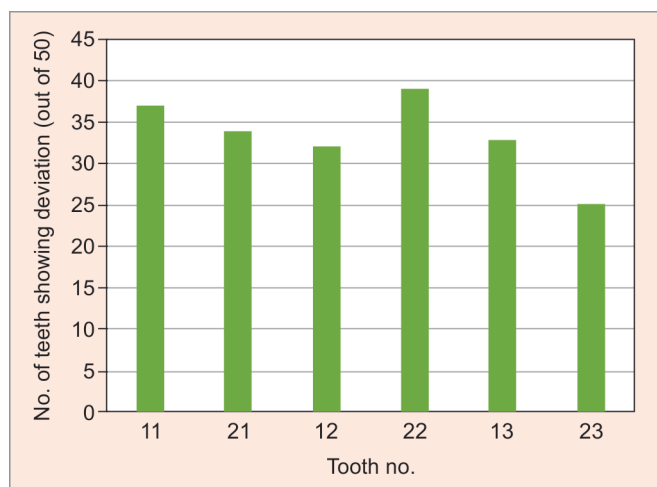


Fig. 6: No. of teeth showing deviation of gingival zenith from the vertical bisected midline (out of 50)

Locating GZ is important as it determines the axial inclination of the tooth and therefore plays an important role while trying to change the mesial-distal dimension of the tooth, diastema closure, and other esthetic procedures. In the present study, GZP and VBM were located using the method described by Chu and Stappert in 2009.⁴

In this study, maximum GZ deviation from the VBM was shown by central incisors and least by canines and this was similar to the results obtained in similar studies conducted by Carolina et al. in 2008⁷ and by Rathod et al. in 2017.²

In the present study, both mesial and distal deviations of GZP from the VBM were seen in all the teeth but the majority of teeth showed distal deviation. These results were comparable with the results obtained by Devapriya et al. in 2019⁸ where a study was conducted to assess the GZ deviation from the VBM. In the same study, the authors reported that mesial deviation was seen i.r.t central and lateral incisors and distal deviation i.r.t canine.⁸ It was also comparable to the study done by Goodlin in 2003⁹ where it was reported that in the case of central incisor the GZ lies at the distal third, for lateral incisor at the VBM and for canine, it varies between the anterior third to the distal third of the crown.⁹

This was contradictory to the results obtained by Magne and Belser in 2002 where they reported a distal deviation of GZ of all the maxillary anterior teeth.⁵ But Carolina et al. in 2008⁷ and Patil et al. in 2020¹⁰ reported that the GZ is not universally displaced towards the distal aspect. Carolina et al. also reported that the frequency and magnitude of distal displacement is tooth dependent and is maximum in central incisors and least in canine which was consistent with the results of the present study.

Regarding the apicocoronal displacement of right and left lateral incisors from the GZL, the right lateral incisor showed slightly more displacement than the left lateral incisor, although the difference was not statistically significant. In 15% of cases, the GZP coincided with the GZL while 75% of cases showed displacement in the range of 0 to 1 mm, and 10% of cases showed displacement >1 mm. Babita et al. in 2019 conducted a study on the GZ of maxillary anterior teeth on 35 mounted maxillary casts and reported that the GZ of 17% of lateral incisors was on or below the gingival line which is consistent with the results of the present study.¹¹

The proper positioning of the GZ is essential for balancing the white and pink esthetics and also influences the emergence profile and axial inclination of teeth.¹⁰ In a study conducted by Kolte et al. in 2020 comparing the lip length and gingival smile line between males and females, it was observed that there was a statistically significant difference in the lip length between males and females with males having a higher lip length than females during smiling. It was also noted that 26.6% of females and 11.6% of males exhibited a high gingival smile line. These data suggest that a prominent amount of the population, especially females display a significant portion of their gingiva during smiling and thus it highlights the importance of this study which describes the GZ position and its deviations in the anterior dentition and its importance in smile designing.¹²

Another esthetic soft tissue parameter that is influenced by the GZ is the gingival line angle, formed by the intersection of GZL with the maxillary midline. In a study comparing gingival line angle with gingival smile line, a significant difference was seen between right and left side for male patients while an insignificant difference was seen for female patients and this gender difference should be considered while reconstructing the soft tissues.¹³

The homogeneity in the esthetic perception of smile between layman and expert was highlighted by a study conducted by Pham et al. in 2021. The authors also stressed the need to substitute symmetry with balance and harmony in esthetic dentistry.¹⁴ Thus, it is important to have in-depth knowledge regarding the gingival parameters for a successful soft tissue rehabilitation.

CONCLUSION

Within the limitations of the study, it is observed that the GZ deviation can be mesial or distal and is tooth dependent. The maximum deviation is seen in the central incisor followed by the lateral incisor and canine. The deviation of the GZP from the VBM in comparison to contralateral teeth is comparable except in the case of lateral incisor where the difference was found to be statistically significant. It was found that in the majority of cases, lateral incisors showed coronal displacement of GZ from the GZL.

Multidisciplinary approaches are often required to increase the treatment predictability. Facial, dentofacial, dentogingival, and dental are the four factors involved in the esthetic analysis according to Cohen, in which GZ and gingival line are key factors in dentogingival elements. Therefore, knowledge of GZ and its deviations are important as GZ plays a key role in smile designing and in other esthetic corrections of the tooth. It helps the clinician to visualize the required procedure and carry it out to obtain a pleasing result even in highly esthetic areas. It is important to adhere to the GZ position guidelines during restorations, surgery or while making templates to make periodontal corrections as any deviations from it will result in unesthetic results.

CLINICAL SIGNIFICANCE

Gingival zenith and its deviation play a major role in esthetic dentistry. According to Cohen, while bilateral symmetry is followed in facial esthetics radiating symmetry should be followed for dentofacial esthetics. Therefore, understanding the GZ deviation seen in the population will enable the clinician to make an evidence-based esthetically pleasing treatment for the patient.

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