

ORIGINAL RESEARCH

Comparative evaluation of gingival zenith positions and levels of maxillary anterior dentition in males and females of Jammu ethnic population

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ABSTRACT

Background: A smile makeover can change your entire appearance virtually overnight. Dental art has been the part of this quest to enhance the aesthetics of the teeth and oral cavity. Gingival zenith is one of the significant clinical parameters of gingival morphology. Hence the aims & objectives of this study was to evaluate and establish the following two clinical parameters and the influence of gender on these parameters i.e. to evaluate and establish the Gingival Zenith Position (GZP) from Vertical Bisected Midline (VBM) axis of each maxillary incisor and canine and also the Gingival Zenith Level (GZL) in an apical coronal direction of the lateral incisors relative to the gingival line joining the tangents of the gingival zenith of the adjacent central incisor and canine under healthy conditions. **Materials and Methodology:** The Study amongst two hundred young adults (100 males and 100 females) within the age group of 21 to 30 years with healthy gingiva were randomly selected. Statistical analysis was done using Statistical Package for Social Sciences (SPSS 11.5). Descriptive statistics were used to find out mean Gingival Zenith Positions and mean Gingival Zenith Level. Comparison of means of GZP and GZL between males and females was done using independent sample t-test, and comparison of mean GZP of different tooth types was done employing Analysis of Variance. The level of significance was fixed at $p < 0.05$. **Results:** The mean Gingival Zenith Position (GZP) for central incisors was found to be 0.73 ± 0.40 mm, for lateral incisor 0.20 ± 0.28 mm, and for canine was 0.34 ± 0.36 mm. There were no statistical significant differences between the mean GZP of central incisors and canines in males and females ($p > 0.05$). However, there were statistically significant differences between males and females in relation to mean GZP of lateral incisors ($p < 0.05$). The mean GZP of lateral incisors in males was found to be higher and statistically significant than that of females. **Conclusion:** The present study provided direct quantitative measurements and qualitative descriptive statistics of the relative position of the Gingival Zenith in the maxillary anterior sextant. This data provided can be used clinically to determine the ideal positioning of the gingival margin during periodontal crown lengthening and root coverage procedures, orthodontic, restorative, and orthognathic surgical therapy.

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INTRODUCTION

A smile makeover can change your entire appearance virtually overnight. The search of beauty can be traced to the earliest civilizations. Dental art has been the part of this quest to enhance the aesthetics of the teeth and oral cavity. The aesthetic evaluation of dento-

facial structures always starts with the smile analysis. Therefore, it is expected from the dentist to preserve, create, or enhance a pleasing smile without impairing function. The crafting of ideal smile requires analysis and evaluation of the face, lips, gingival tissues, and

teeth including an appreciation of how they appear collectively.¹

The physiologic gingival architecture has been described by **Prichard J**² in 1961 as “the one in which the inter-dental area is conical and coronally positioned to the facial and oral plates of bone, which have a parabolic shape and flow smoothly from the inter-dental area; that follows the shape of the cemento-enamel junction”. Later **Bensimon GC**³ in 1999 described it as “allowing a thin, scalloped, knife edged gingival contour with pyramid shaped papillae that fill the inter-proximal space”. This knife-edged marginal gingival contour is primarily affected by the degree of concavity and convexity of the tooth surface. Thus, higher the convexity of the root surface, more markedly scalloped is the gingival margin. Such parabolic architecture is critically outlined by the zenith, which is defined as the most apical point of the gingival marginal scallop (**Mattos and Santana 2008**).⁴

Literally, meaning of the word ‘zenith’ is the highest point reached by a celestial or other object, or the point in the sky or celestial sphere directly above an observer. Gingival zenith is one of the significant clinical parameters of gingival morphology. Other significant feature of gingival morphology is the gingival line, which is defined as the line joining the tangents of the gingival zeniths of the central incisor and canine.

The position of the gingival zenith directly relates to the aesthetics of the smile (**Goodlin**⁵ **2003**). The impact on the beauty of a smile from an uneven 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. The gingival zenith affects other objective criteria, including the balance of gingival levels (too coronal or apical), the tooth axis (too distal or mesial), the tooth dimension (too coronal or apical), and the tooth form (triangular becomes ovoid if too coronal)(**Cooper 2008**).⁶

Various authors have recommended different positions of the gingival zeniths in maxillary anterior teeth. There are numerous studies suggesting different information on where the Gingival Zenith Position (GZP) should be located from Vertical Bisected Midline (VBM) axis of each individual maxillary anterior tooth and where it should be placed.

Thus, understanding the dento-gingival interface would clinically help to achieve a more satisfactory aesthetic outcome during interdisciplinary diagnosis and treatment. There is no conclusive evidence regarding the information about the gingival levels of the lateral incisors relative to the gingival line joining the tangents of the gingival zenith of the adjacent central and canine under healthy conditions. To our present knowledge, very rare studies have been done

to evaluate the influence of gender on the gingival zenith positions and levels.

Hence the aims & objectives of this study was to evaluate and establish the following two clinical parameters and the influence of gender on these parameters i.e. to evaluate and establish the Gingival Zenith Position (GZP) from Vertical Bisected Midline (VBM) axis of each maxillary incisor and canine and also the Gingival Zenith Level (GZL) in an apical coronal direction of the lateral incisors relative to the gingival line joining the tangents of the gingival zenith of the adjacent central incisor and canine under healthy conditions.

MATERIALS AND METHOD

The present study was conducted on the relatives of the patients visiting the Out-Patient Department of Periodontics and students of Jammu. Two hundred young adults (100 males and 100 females) within the age group of 21 to 30 years with healthy gingiva were randomly selected. Approval for the study had been obtained from institutional ethical review board (IRB). All subjects were informed about the nature of the study and their informed consent was taken. Persons with restored maxillary anterior teeth, crowding or spacing in anterior maxillary teeth, gingival recession, gingival overgrowth, or altered passive eruption and missing tooth in anterior region of maxilla were excluded in the study. After inclusion of the individual in the study each subject underwent a full diagnostic workup which included detailed medical and dental history and clinical examination. Alginate impressions of the maxillary arch of the selected subjects were made in stock trays and poured in type III dental stone according to the manufacturer’s instructions. The morphometric analysis was done on the respective stone cast. A digital calliper with a light emitting diode (LED) display was used to measure 2 sites per tooth of the anterior maxillary teeth on the respective stone casts.⁷ The digital calliper was calibrated prior to each measurement. Reference lines were drawn on the stone casts with indelible marking pencil using 2.5 magnification optical loupes. The proximal incisal contact area position and the apical contact area position served as the reference points to define the tooth width Each width was divided in half, and the centre points were marked. Centre points were extended to a line toward the gingival aspect of the clinical crown to define the Vertical Bisected Midline (VBM).

The most apical point of the free gingival margin was marked (Fig 1a and 1b) as gingival zenith. The distance of the gingival zenith to the VBM was measured for central incisors, lateral incisors, and canines to obtain the gingival zenith position (GZP) in a medio-lateral direction.



Fig 1a- Mesial and distal contact area points connected with reference line.
Fig 1b- Mesial and distal contact area points connected with reference lines

The gingival line (i.e. a line joining the tangents of the gingival zeniths of the central incisor and canine) joining maxillary centrals to the canines was drawn. The distance of the contour of the gingival margin for the lateral incisor was measured from the line to obtain the Gingival Zenith Level (GZL) in an apico-coronal direction of the lateral incisors relative to the adjacent central and canine gingival zenith points. The data thus collected was subjected to statistical analysis. Statistical analysis was done using Statistical Package for Social Sciences (SPSS 11.5). Descriptive statistics were used to find out mean Gingival Zenith Positions and mean Gingival Zenith Level.

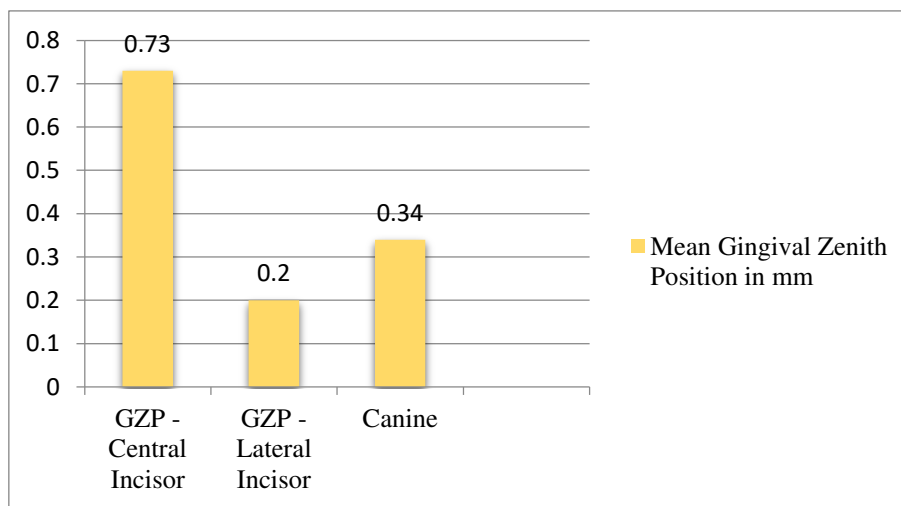
Comparison of means of GZP and GZL between males and females was done using independent sample t-test, and comparison of mean GZP of different tooth types was done employing Analysis of Variance. The level of significance was fixed at $p < 0.05$.

RESULTS

Table 1 shows the mean Gingival Zenith Position (GZP) of maxillary anterior teeth. For central incisors the mean Gingival Zenith Position (GZP) was found to be $0.73 \pm 0.40\text{mm}$, for lateral incisor $0.20 \pm 0.28\text{mm}$, and for canine was $0.34 \pm 0.36\text{mm}$. (Graph 1)

Table 1:- Mean Gingival Zenith Position (GZP) of maxillary anterior teeth.

GZP	n	Range	Minimum	Maximum	Mean \pm SD
Central Incisor	200	1.98	0.00	1.98	0.73 ± 0.40
Lateral Incisor	200	1.09	0.00	1.09	0.20 ± 0.28
Canine	200	1.67	0.00	1.67	0.34 ± 0.36



Graph 1:- Comparison of mean Gingival Zenith Position. (GZP)

Table 2 shows comparison between mean Gingival Zenith Positions of central incisors, lateral incisors and canines which was done using one-way ANOVA. The analysis showed that there were statistical significant differences in the mean GZP values of different tooth types.

Table 2:- Comparison of mean Gingival Zenith Position (GZP) for central incisors, lateral incisors and canines.

GZP	N	Mean \pm SD	p value
Central Incisor	200	0.73 ± 0.4	

Lateral Incisor	200	0.20±0.28	0.00*
Canine	200	0.34±0.36	

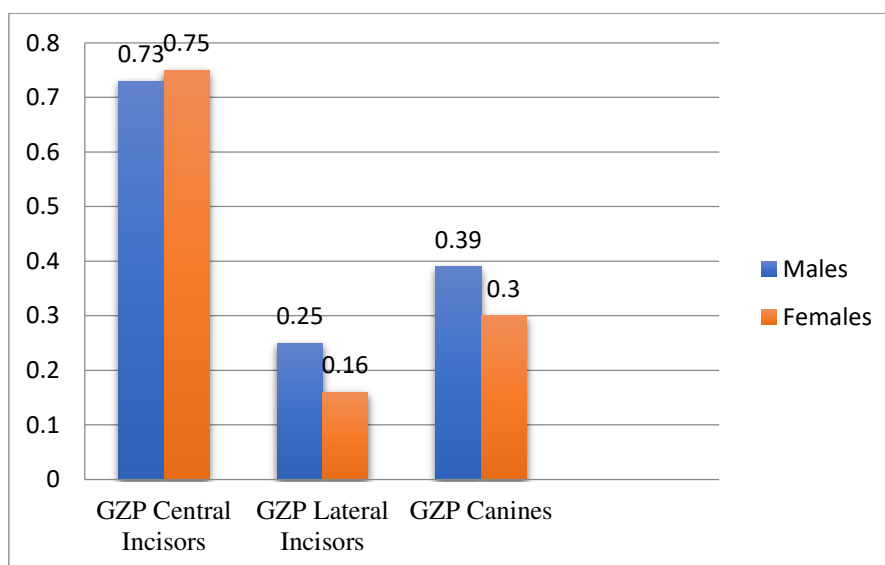
*p<0.001: Highly Significant (HS)

Table 3 shows comparisons between mean Gingival Zenith Positions(GZP) values between males and females. There were no statistical significant differences between the mean GZP of central incisors and canines (p>0.05). However, there were statistically significant differences between males and females in relation to mean GZP of lateral incisors (p<0.05). The mean GZP of lateral incisors in males was found to be higher and statistically significant than that of females.(**Graph 2**)

Table 3:- Gender wise comparison of Gingival Zenith Position (GZP) for central incisors, lateral incisors and canines for males and females.

GZP	Male (100) Mean± SD	Female (100) Mean ± SD	p-value
Central Incisor	0.73±0.40	0.75±0.40	0.73
Lateral Incisor	0.25±0.29	0.16±0.27	0.03*
Canine	0.39±0.36	0.30±0.36	0.11

*p≤0.05:- Significant; p>0.05:- Not Significant.



Graph 2:- Gender-wise comparison of mean Gingival Zenith Position.(GZP)

Distance of the Gingival Zenith Level (mm) of the lateral incisors in an apico-coronal direction relative to the gingival line, joining the tangents of the Gingival Zenith Position of the adjacent central incisor and canine teeth is shown in table 4.

Table 4 shows the mean Gingival Zenith Level (GZL) for lateral incisor which was found to be 0.84 ± 0.38 mm. The range of values measured was 0 to 1.98 mm

Table 4:- Mean Gingival Zenith Level (GZL) for lateral incisor.

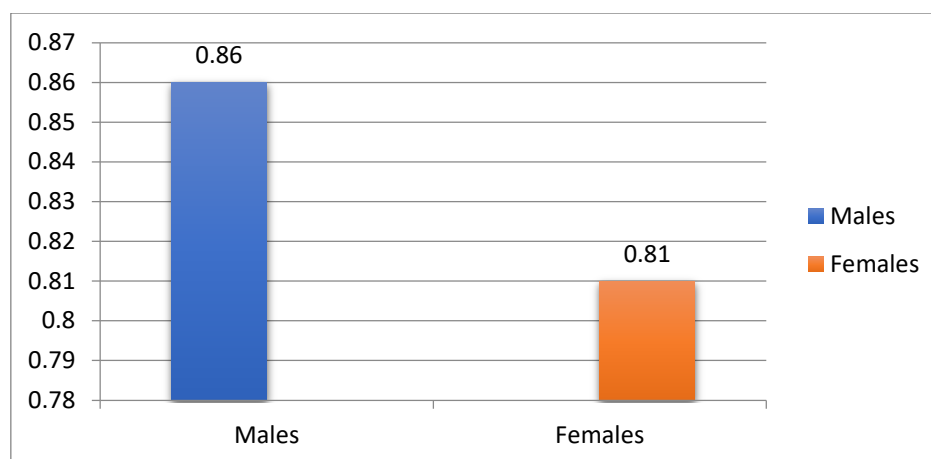
	n	Range	Minimum	Maximum	Mean±SD
Gingival Zenith Level	200	1.98	0.00	1.98	0.84±0.38

Table 5 shows the comparison of mean Gingival Zenith Level (GZL) in males and females. The mean GZL in males was found to be 0.86 ± 0.37mm, and in females it was 0.81± 0.38mm. There was no statistical significant difference between the mean GZL in males and females (p>0.05).(**Graph 3**)

Table 5:- Gender wise comparison of mean Gingival Zenith Level (GZL) of the population.

Gingival Zenith Level	Males (100) Mean±S D	Females (100) Mean ±SD	p-value*
	0.86±0.37	0.81±0.38	0.42

p>0.05:- Not Significant



Graph 3:- Gender wise Comparison of mean Gingival Zenith Level (GZL)

DISCUSSION

The assessment of the aesthetic smile begins with the lips at the outer limits and ends with the teeth at its inner limit. It is the harmonious synchronization between these factors, namely, the teeth, gingiva and lips that lead to an aesthetic or pleasing smile. Careful registration of these factors will lead to a sound diagnosis and treatment plan which will facilitate treatment and provide for more stable and aesthetic results.⁸

Gingival aesthetics has always been an important component of a beautiful smile. Thus the appearance of the gingival tissues surrounding the teeth plays an important role in the aesthetics of the anterior maxillary region of the mouth.

Details such as the Gingival Zenith Position (GZP) and the Gingival Zenith Level (GZL) can significantly influence the esthetic appearance of a smile. Many factors are important for aesthetics and limited research has been conducted to quantify these two clinical parameters:

(1) The GZP i.e. the distance of the gingival zenith from the VBM (Vertical Bisected Midline) axis of each individual maxillary anterior tooth.

(2) The GZL i.e. the distance of the gingival zenith of the lateral incisors in an apico-coronal direction from the line joining the tangents of the gingival zenith of the adjacent central incisor and canine under healthy conditions.

However, studies discussing various aspects related to the gingival contours of the maxillary anterior teeth, have presented conflicting information on where the GZP should be.

In the present study the distance of the gingival zenith position (mm) from the vertical bisected midline of the clinical crown along the long axis for central incisors, lateral incisor and canine was measured. For central incisors the mean Gingival Zenith Position (GZP) was found to be $0.73 \pm 0.40\text{mm}$, for lateral incisor $0.20 \pm 0.28\text{mm}$, and for canine was $0.34 \pm 0.36\text{mm}$. It was found that there was distal displacement of the GZPs of all three teeth i.e. central incisor, lateral incisor and canine. These findings are

similar to the studies done by **Magne and Belser⁹&Morr¹⁰** who suggested that the GZP was distal to the long axis of all the maxillary anterior teeth.

On comparing the Gingival Zenith Positions (GZP) of central incisors, lateral incisors and canines it was found that the value of mean GZP of central incisors was more statistically significant than that of lateral incisors and canines. Also, the mean GZP of canines was significantly higher than that of lateral incisors. According to the results in the present study gingival zenith position was more distally placed on central incisors & canines than lateral incisors. These results are in accordance with the study done by **Rufenacht¹¹**,¹² who found that the GZP was distally displaced on the central incisors and canines only, whereas those of the lateral incisors were coincident with the vertical bisected midline which is in contrast to our study. The distal placement of GZP in lateral incisors in the present study is in accordance with the study done by **Stein and Kay (1982)¹³** who proposed that the gingival zenith is distal to the long axis of the central incisors and lateral incisors. **Magne and Belser⁹ and Morr¹⁰** also suggested that the zenith is placed distal to the long axis of central incisors, lateral incisors and canine. Similar results were observed by **Goodlin⁵** who described the GZP for central incisors at the distal third, laterals at the VBM, and canines ranging from the anterior third to the distal third of the VBM. According to findings by **Chu et al⁷**, the mean location of the GZP from the vertical bisected midline (VBM) of the clinical crown of central incisors, lateral incisors, and canines was about 1 mm, 0.4 mm distally, and 0 mm, respectively. The GZP of the lateral incisors were almost concurrent with the VBM, and that of canines were coincident with the VBM within each tooth group. The findings of the present study are in contrast to the studies done by **Mattos and Santana⁴** and also **M Zagar et al¹⁴**, where the lateral displacement of the zenith was greater in central incisor teeth than in lateral incisor teeth, which, in turn, was greater than in canine teeth.

In the present study the gender wise comparison of mean GZP for central incisors, lateral incisor and canines for males and females was done. This comparison was done between 100 males and 100 females of same age group. There was no statistical significant difference between males and females in relation to the mean GZP of central incisors and canines. However, there were statistical significant differences between males and females in relation to mean GZP of lateral incisors which were higher in males than that of females. No similar study has been done before showing the gender difference in relation to the GZP.

In the present study, the mean distance of the contour of the gingival margin in an apico-coronal direction of the lateral incisors (GZL) relative to the gingival line joining the tangent of the adjacent central incisor and canine GZPs was found to be coronally placed at 0.84 ± 0.38 mm. The range of values measured was 0 to 1.96 mm. These findings are in accordance with the study done by **Mattos and Santana**⁴ where the coronal displacement of the gingival zenith of the lateral incisor was found to be 0.70 ± 0.60 mm. **Rufenacht**^{11,12} suggested that for a Class 1 occlusion, the ideal GZL should be where the gingival contours of the central incisors and canines are at the same level and the lateral incisor positioned slightly more coronal. In Class 2, division 2 malocclusions, the GZL of the lateral incisors are more apical compared with that of the central incisors and canines, as the lateral incisors tend to overlap the distal aspects of the central incisors. The mean GZL values presented herein differ from those reported by **Charruel and colleagues**¹⁵ by + 0.2 mm since they measured photographs taken of diagnostic casts from the frontal perspective versus direct measurements of casts. Variations for photography variances were accounted for in that study. Similarly **Chu et al**^{7, 16, 17} measured the GZL in an apical-coronal direction of lateral incisors relative to the gingival tangential zenith line joining adjacent central incisor and canine which was found to be approximately 1 mm under healthy conditions. The range of values measured was 0 to 1.8 mm.

In the present study the gender wise comparison of mean GZL was done for males and females. This comparison was done between 100 males and 100 females of same age group. There was no statistical significant difference between males and females in relation to the mean GZL. Similar results were observed by **Charruel et al**¹⁵ where analysis of the data showed no difference between genders.

Thus, as evidenced above, there was a significant variation in the previous descriptions of the ideal positioning of the Gingival Zenith, which was likely influenced by the largely anecdotal nature of the observations, the undefined characteristics of the population studied, and the lack of an adequate description of the methods used for data acquisition and interpretation. Considering the multidisciplinary

diagnostic and therapeutic importance of the ideal positioning of the Gingival Zenith, further investigations on the subject are warranted.

The present study provided direct quantitative measurements and qualitative descriptive statistics of the relative position of the Gingival Zenith in the maxillary anterior sextant. The data provided can be used clinically to determine the ideal positioning of the gingival margin during periodontal crown lengthening and root coverage procedures, orthodontic, restorative, and orthognathic surgical therapy.

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