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

Rohit Sharma^{1*}, Eeshita Sharma², Prashant Singh³, Sandeep Kaur⁴, Kirandeep Kaur⁵

^{1,3,5}Reader, ²Senior Lecturer, ⁵Lecturer, ^{1-3,4}Dept. of Periodontics, Dept. of Oral Medicine & Radiology, ^{1,2}Himachal Dental College, Sundernagar, Mandi, Himachal Pradesh, ^{3,5}Institute of Dental Sciences, Sehora Jammu, Jammu & Kashmir, ⁴Indira Gandhi Government Dental College & Hospital, Jammu (J&K), India

***Corresponding Author: Rohit Sharma**

Email: rohit@htdentalimplant.com

Abstract

Purpose: 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. 1) To evaluate and establish the Gingival Zenith Position (GZP) from Vertical Bisected Midline (VBM) axis of each maxillary incisor and canine. 2) To evaluate 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. 3) To compare the Gingival Zenith Position (GZP) and Gingival Zenith Level (GZL) in male and female subjects.

Materials and Methods: Two hundred young adults (100 males and 100 females) within the age group of 21 to 30 years with healthy gingiva were randomly selected with proper inclusion and exclusion criteria. Alginate impressions of the maxillary arch of the selected subjects were made in stock trays and poured in type III dental stone. 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. 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 point 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 as gingival zenith. The distance of the gingival zenith to the VBM was measured. The data thus collected was subjected to statistical analysis.

Results: The Gingival Zenith Positions of all three teeth i.e. central incisor, lateral incisor and canine lies distally to the vertical bisected midline without any gender bias. The Gingival Zenith Level in an apical-coronal direction of lateral incisors relative to the gingival tangential zenith line joining adjacent central incisor and canine was approximately 0.84 mm placed coronally under healthy conditions.

Keywords: Gingival zenith, Free gingival margin, Clinical crown.

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. Healthy gingiva is an important component of a beautiful smile. Gingival health includes maintenance of gingival morphology and contour. 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. Such an ideal smile depends on the symmetry and balance of the dento-facial features.^[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”.^[2] 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”.^[3] 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]

The present study was carried out to evaluate and establish the following two clinical parameters and the influence of gender on these parameters i.e. 1) To evaluate and establish the Gingival Zenith Position (GZP) from Vertical Bisected Midline (VBM) axis of each maxillary incisor and canine. 2) To evaluate 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. 3) To compare the Gingival Zenith Position (GZP) and Gingival Zenith Level (GZL) in male and female subjects.

Materials and Methods

The present study was conducted on the relatives of the patients visiting the Out-Patient Department of Periodontics and students of Himachal Dental College and Hospital, Sundernagar. Two hundred young adults (100 males and 100 females) within the age group of 21 to 30 years with healthy gingiva were randomly selected.

Inclusion criteria

1. Subjects with non restored maxillary anterior teeth.
2. Absence of crowding or spacing in maxillary anterior teeth.
3. Absence of any signs of gingival recession, gingival overgrowth, or altered passive eruption.⁴ There should be no missing tooth in anterior region of maxilla.

Exclusion criteria

1. Any evidence or history of tooth alteration, i.e. restorative treatment, traumatic injury, occlusal wear, and cervical abrasion of maxillary anterior teeth.
2. Patient who has undergone any periodontal surgery or orthodontic treatment involving maxillary anterior teeth.
3. Any evidence of gingival alteration, i.e. gingival overgrowth, inflammation, altered passive eruption and gingival recession.
4. Patients with bleeding on probing (BOP) and pocket depth (PD) more than 3mm.
5. Use of any medication known to influence the gingival morphology. 6) Smoker and pregnant patients.

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 (Fig. 1a&b).

Impression making

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. Only those casts were selected in which gingival margins of maxillary anterior teeth were clearly visible. The morphometric analysis was done on the respective stone casts.(Fig. 2a& 2b).

Steps for measuring Gingival Zenith Positions and Gingival Zenith Levels 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(Fig. 3) 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(Fig.4a, 4b, 5a & 5b) to define the tooth width(Fig.6a & 6b). Each width was divided in half, and the centre points(Fig. 7a & 7b) 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. 8a & 8b) as gingival zenith. The distance of the gingival zenith to the VBM was measured(Fig. 9a & 9b)for central incisors, lateral incisors, and canines to obtain the gingival zenith position (GZP) in a medio-lateral direction.

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 (Fig. 10a & 10b) was drawn.⁸The 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(Fig. 11a & 11b) relative to the adjacent central and canine gingival zenith points.

The data thus collected was subjected to statistical analysis.

Results

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 $p < 0.05$.

The results presented are on account of the following parameters- 1. 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. 2. Comparison of Gingival Zenith Position for central incisors, lateral incisor and canines. 3. Comparison of Gingival Zenith Position for central incisors, lateral incisor and canines for males and females. 4. 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. 5. Gender-wise comparison of Gingival Zenith Level of the population.

1. Distance of the Gingival Zenith Position (mm) from the Vertical Bisected Midline(VBM) of the clinical crown along the long axis for central incisors, lateral incisors and canines. 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 $0.34 \pm 0.36\text{mm}$.
2. Comparison of mean Gingival Zenith Position(GZP) for central incisors, lateral incisor and canines. 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 5). The post-hoc analysis showed that the mean GZP of central incisors was higher than that of lateral incisors and canines ($p < 0.05$). Also, the mean GZP of canines

- was found to be higher than that of lateral incisors ($p < 0.05$). The p value was found to be highly significant on comparison for central incisors, lateral incisors and canines. (Graph 1).
- Gender wise comparison of Gingival Zenith Position (GZP) for central incisors, lateral incisor and canines for males and females. 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)
 - 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. 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.
 - Gender wise comparison of mean Gingival Zenith Level (GZL) of the population. 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 ± 0.37 mm, and in females it was 0.81 ± 0.38 mm. There was no statistical significant difference between the mean GZL in males and females ($p > 0.05$). (Graph 3).

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

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	0.00(HS)*
Lateral Incisor	200	0.20 ± 0.28	
Canine	200	0.34 ± 0.36	

* $p < 0.001$:- Highly Significant (HS)

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 $\pm$ SD	Female (100) Mean $\pm$ SD	p-value
Central Incisor	0.73 ± 0.40	0.75 ± 0.40	0.73(NS)
Lateral Incisor	0.25 ± 0.29	0.16 ± 0.27	0.03(S)
Canine	0.39 ± 0.36	0.30 ± 0.36	0.11(NS)

$p \leq 0.05$:- Significant(S); $p > 0.05$:- Not Significant (NS).

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

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

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

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

* $p > 0.05$:- Not Significant(NS)

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

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

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

Fig 1: a: Photograph of gingival architecture of a male subject; **b:** Photograph of gingival architecture of a female subject.

Fig 2: a: Cast poured in type III dental stone after making alginate impression; **b:** Cast poured in type III dental stone after making alginate impression.

Fig 3: Digital caliper was calibrated prior to each measurement.

Fig 4: a: Proximal incisal contact area point and apical contact area point were marked that served as the reference points to define the tooth width; **b:** Proximal incisal contact area point and apical contact area point were marked that served as the reference points to define the tooth width.

Fig 5: a: Mesial and distal contact area points connected with reference line; **b:** Mesial and distal contact area points connected with reference lines.

Fig 6: a: Tooth width measured at the contact area points with digital vernier caliper; **b:** Tooth width measured at the contact area points with digital vernier caliper.

Fig 7: a: Each width divided in half and centre points were marked; b: Each width divided in half and centre points were marked.

Fig 8: a: Centre points extended to a line toward the gingival aspect of the clinical crown to define the vertical bisected midline (VBM). Highest point of the free gingival margin was marked; b: Centre points extended to a line toward the gingival aspect of the clinical crown to define the vertical bisected midline (VBM). Highest point of the free gingival margin was marked.

Fig 9: a: The highest point of the free gingival margin was measured from the vertical bisected midline (VBM) to obtain the gingival zenith position (GZP) in a medio-lateral direction; b: The highest point of the free gingival margin was measured from the vertical bisected midline (VBM) to obtain the gingival zenith position (GZP) in a medio-lateral direction.

Fig 10: a: The gingival line (i.e. a line joining the tangents of the gingival zeniths of the gingival zeniths of the central incisor and canine) was drawn; b: The gingival line (i.e. a line joining the tangents of the gingival zeniths of the gingival zeniths of the central incisor and canine) was drawn.

Fig 11: a: The distance of the gingival zenith of 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; b: The distance of the gingival zenith of 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.

Discussion

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. Abnormalities in symmetry and contour can significantly affect the harmonious appearance of the natural or prosthetic dentition.^[9-12] Beautiful restorations surrounded by unattractive gingival tissues can have a negative impact on a smile.¹⁰ Consequently, any dental procedure performed in this zone can be an aesthetic challenge due to the visibility of the dentogingival interface.

Directly related to the aesthetics of the smile is the position of the gingival zenith. The gingival zenith is defined as the most apical point of the gingival marginal scallop. This important landmark was described as having the specific spatial orientation in the apico coronal and mesio- distal directions.^[11]

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. The appropriate placement of the gingival zenith is critical, as it helps to determine the desired axial inclination of the tooth by maneuvering the line angle of the tooth vertical axis. Subsequently, knowing the GZP of each maxillary anterior tooth from the VBM as well as the GZL of the lateral incisors can help facilitate a reference point during esthetic periodontal plastic surgery procedures.

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 Belser^[12] & Morr T^[13] 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 Rufenacht^[14] 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.

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 was 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 $0.84 \pm 0.38\text{mm}$. 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 $0.70 \pm 0.60\text{mm}$.

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.

Conclusions

The present study was conducted on two hundred young adults (100 males and 100 females) in the age group of 21 to 30 years with healthy gingiva, who were the relatives of the patients visiting the Out-Patient Department of Periodontics and students of Himachal Dental College and Hospital, Sundernagar. All subjects were informed about the nature of the study and their informed consent was taken. Alginate impressions were made and maxillary casts were obtained. A digital caliper was used for the measurement of the GZP and GZL of the maxillary anterior teeth on the respective stone casts. The data thus collected was subjected to statistical analysis.

The conclusions drawn from the present study are:- 1) The mean location of the Gingival Zenith Position (GZP) from the Vertical Bisected Midline (VBM) of the central incisors, lateral incisors, and canines was about 0.73 mm, 0.20 mm and 0.34 mm, distal respectively. 2) The Gingival Zenith Positions of all three teeth i.e. central incisor, lateral incisor and canine lies distally to the vertical bisected midline. While the mean GZP of central incisor is more distal than that of canines which in turn is more distal than that of lateral incisors. 3) There was no statistical significant difference between males and females regarding the mean Gingival Zenith Position of central incisors and canines. But the mean Gingival Zenith Position of lateral incisors was found to be more distal in males than that of females. 4) The Gingival Zenith Level in an apical-coronal direction of lateral incisors relative to the gingival tangential zenith line joining adjacent central incisor and canine was approximately 0.84 mm placed coronally under healthy conditions. 5) There was no statistical significant difference regarding the mean Gingival Zenith Levels between males and females.

The information presented in this study can be clinically applied to reestablish the proper intra-tooth GZPs of the maxillary anterior teeth during periodontal crown lengthening or root coverage procedures. In addition, the intra-arch gingival level of the lateral incisor gingival zenith relative to the adjacent central and canine teeth can be appropriately established.

These reference points could be used in conjunction with other subjective and objective esthetic parameters during diagnosis, treatment planning, and in reconstructing a natural smile.

Funding

None.

Conflict of Interest

None.

References

1. Londono B, Miguel A, Botero M, Paola. The smile and its dimensions. *Rev Fac Odontol Univ Antioq.* 2012;23:253-365.
2. Prichard J. Gingivoplasty, gingivectomy and osseous surgery. *J Periodontol.* 1961;32:275-82.
3. Bensimon GC. Surgical Crown- Lengthening Procedure to Enhance Esthetics. *Int J Periodontics Restorative Dent.* 1999;19(4):332-41.
4. Mattos CML, Santana RB. A Quantitive Evaluation of the Spatial Displacement of the Gingival Zenith in the Maxillary Anterior Dentition. *J Periodontol.* 2008;79:1880-5.
5. Goodlin R. Gingival Aesthetics: A Critical Factor in Smile Design. *Oral Health Dent Pract Managt.* 2003.
6. Cooper LF. Objective criteria: guiding and evaluating dental implant esthetics. *J Esthet Restor Dent.* 2008;20(3):195-205.
7. Chu SJ, Tan J, Stappert C, Tarnow D. Gingival Zenith Positions and Levels of the Maxillary Anterior Dentition. *J Esthet Restor Dent.* 2009;21(2):113-20.
8. Ahmad I. Geometric considerations in anterior dental aesthetics: restorative principles. *Pract Periodontics Aesthet Dent* 1998;10:813-22.
9. Lai YJ, Silvestri L, Girard B. Anterior Esthetic Crown- Lengthening Surgery: A Case Report. *J Can Assoc.* 2001;67(10):600-3.
10. Patil VA, Desai MH. Assessment of gingival contours for esthetic diagnosis and treatment: A clinical study. *Indian J Dent Res.* 2013;24:394-5.
11. Pawar B, Mishra P, Banga P, Marawar P. Gingival Zenith and its role in redefining esthetics: A clinical study. *J Indian Soc Periodontol.* 2011;15:135-8.
12. Magne P, Belser U. Bonded porcelain restorations in the anterior dentition. A biomimetic approach. *Carol Stream(IL): Quintessence;* 2002, 58–64.
13. Morr T. Understanding the Esthetic Evaluation for Success. *J Calif Dent Assoc.* 2004;32(2):153-60.
14. Rufenacht C. Fundamentals of esthetics. *Berlin: Quintessence;* 1990, pp. 67–134.

How to cite: Sharma R, Sharma E, Singh P, Kaur S, Kaur K. Comparative evaluation of gingival zenith positions and levels of maxillary anterior dentition in males and females. *Global J Dent Specialty.* 2021;1(3):83-9.