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A quantitative evaluation of gingival zenith position of maxillary central incisors in different facial forms

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Abstract:
Purpose: *To evaluate gingival zenith position (GZP) of maxillary central incisors in relation to vertically bisected midline by means of dental casts and digital caliper in different facial forms.*
Methods: *One hundred and four young healthy subjects divided into four groups based on their facial forms: oval, square, square tapered and tapered. Maxillary casts prepared and reference lines were drawn on maxillary central incisors and bilateral measurements, using digital caliper were recorded. The data were analyzed using ANOVA and Tukey HSD ($p<0.05$).*
Results: *The mean distance of GZP IN relation to vertically bisected midline of maxillary incisors was 1.06mm, 1.12mm, 1.04mm and 1.04mm in oval, square, square tapered and tapered face types respectively. Comparison between the groups was statistically significant.*
Conclusions: *There was statistically significant difference of GZP in relation to vertical bisected midline within four face types. The contralateral comparisons revealed no statistical difference between maxillary left and right central incisor thus emphasizing bilateral symmetry.*
Keywords: *Facial forms; Gingival zenith position; Maxillary central incisors.*

I. Introduction

Dentogingival complex is a part of dentofacial esthetic paradigm [1].What may seem proportional and balanced from a distance may reveal discrepancies when observed closely. Without evaluation and correction of these minute discrepancies, perfection cannot be achieved.

A perfect smile that harmonizes the face is most desirable. Smile design starts with the analysis of the face, and then moves to the smile and to the teeth themselves [2]. The basic shape of the face as viewed from the frontal aspect can be categorized into oval, square, square tapering, tapering [3]. The basic tooth forms include: Oval, square or triangular, which determine the degree of gingival scallop. Oval, square tooth form presents with shallower gingival scallop whereas triangular form shows pronounced scallop [4]. Along with this, another significant clinical parameter of gingival morphology is Gingival Zenith (GZ), the most apical aspect of the free gingival margin (FGM) which plays a key role in esthetics. Its position is found to be distal to the vertical bisected midline (VBM) for central and lateral incisor, and for canine it is said to coincide with the VBM[5]. But variations exist with respect to lateral incisor and canine. According to Cohen gingival zenith postion (GZP) is present distally for central incisor and canine, but for lateral incisor it coincides with VBM [1].This aspect plays a pivotal role in restorative and esthetic procedures.

The maxillary central incisor is the most prominent tooth in the maxillary anterior segment. This is the tooth that is most frequently and commonly traumatized [6]. It is said that the ideal maxillary central incisor should be approximately 80% width compared with height, but it has been reported to vary between 66% and 80%. A higher width/height ratio means a squarer tooth, and a lower ratio indicates a longer appearance. The ranges of height and width are important as the disproportionality of a tooth can be evaluated with regard to what parameter is at fault and needs improvement [7]. Hence it becomes important to note the GZP in relation to VBM.

Whether facial forms decide the shape of teeth and gingival zenith position is not known. Therefore an attempt is made to locate the gingival zenith position in varied shaped central incisors in subjects of different facial forms. Thereby, establishing the treatment outcomes best suiting the esthetic appearance of the given facial form of the patient. Such consideration helps during treatment planning of smile designing, crown lengthening procedure, during crown placement, teeth selection, implant esthetics and laminates.

II. Material And Methods

This study has been carried out in Dept. of Periodontics, ACPM dental college Dhule, Maharashtra, India after the approval by the Institutional Review Board. One hundred four young samples of dental students ranging from 18-25 years were randomly selected. Based on their facial morphology they were divided into 4

groups: oval, square, square tapering and taper who met the inclusion criteria. The study population included, subjects with healthy gingival status, absence of any type tooth deformity due to trauma or any other cause or any malocclusion including rotation, tipping proclination, spacing or any gingival surgical treatment for aesthetic or elimination of periodontal problem.

III. Measurements

Alginate impressions of maxillary arch were taken and poured with dental stone. To define the VBM of each clinical crown, the tooth width was measured at two reference points. The proximal incisal contact area position and the apical contact area position served as the reference points. Each width was divided in half, and the center points were marked. Center points were extended to a line toward the gingival aspect of the clinical crown to define the VBM. The highest point of the free gingival margin was marked. The distance of the highest gingival margin position to the VBM was measured along the VBM of central incisors. The measurement taken was the distance between vertical bisected midline and gingival zenith line of right and left central incisor. The measurement was performed under direct light with a digital caliper (SHANGHAIHAMES.Co.Ltd) with a resolution of 0.01 mm for accuracy [Fig 1 and 2].

IV. Results

Statistical Analysis:

Statistical analysis was carried out on multiple comparisons using Tukey HSD and ANOVA of distance of GZP in relation to VBM in between different facial type. The significance value was set at $p<0.05$.

All the central incisors displayed distal GZP from VBM. The mean distance of GZP in relation to VBM of maxillary central incisors (11&21) in oval, square, square taper and taper was 1.06mm, 1.12mm, 1.04mm, and 1.04mm respectively. When comparison was made between the groups through ANOVA, statistically significant difference at $p<0.05$ was noted (Table 1).There was no statistical significant difference observed when comparison was made between GZP and VBM in between11and 21 teeth of different facial forms.(Table 2).When multiple comparison of GZP in relation to VBM of maxillary teeth (11 and 21) between different faces was made using Tukey HSD, there was statistically significant difference in between square face type with either square tapering or taper face (Table 3). Multiple comparison of GZP andwith VBM of 11 and 21 tooth in different faces through ANOVA showed no statistical significant difference in between oval, square, square taper and taper face type (Table 4 and 5). Only two cases showed GZP coinciding with VBM in square tapering facial form.

V. Discussion

The crafting of ideal smile requires analysis and evaluations of the face, lips, gingival tissues, and teeth and an appreciation of how they appear collectively Such an ideal smile depends on the symmetry and balance of the facial and dental features[8].

The appearance of gingival tissues plays an important role in the esthetics of the maxillary anterior teeth and the abnormalities in symmetry and contour can significantly affect the harmony of the natural or prosthetically restored dentition. Gingival morphology, contour and visibility play important role in a beautiful smile and are among the first fundamental esthetic objectives during treatment planning. They are also essential to consider prior to the final decision about the prosthodontic esthetic treatment.

Gingival zenith position is the most apical part of gingival margin which significantly influence the esthetics. It is an important anatomic landmark and has been described to have a specific spatial orientation in the apico-coronal and mesio-distal directions. 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[9].

Various morphometric studies and critical evaluations have been carried out in the past stating that the GZP for central incisor is distal to the vertical bisected midline. Minor controversies exist regarding GZP in relation to VBM for lateral incisors and canine. The GZP for lateral incisor is said to be coinciding with VBM [4,7,10,11,12], as contrast to Stephen and Joycelyn in 2009 who stated that GZP for canine was centralized along the long axis of it [5]. Mattos CML in 2008 in a quantitative evaluation of spatial displacement of GZ in the maxillary anterior dentition, found that GZ is not universally displaced towards distal aspect and the frequency and magnitude of distal displacement is found to be larger in central incisor, than in lateral which in turn is larger than canine[9]. Goodlin 2003 and Stephen 2009 were of the opinion that central incisors displayed 1mm, laterals 0.4mm deviation from VBM. Goodlin also suggested that the position of zenith will help create the desired axial inclination of the tooth by changing the line angle position of the long axis of the tooth[10].

Zagar M in 2010 evaluated specific distal displacement of the gingival zenith in the maxillary anterior dentition in young adults, measuring the gingival zenith position of the maxillary incisors and canines. And

found that the frequency and magnitude of distal displacement is tooth-dependent and larger in central than in lateral incisors, which in turn, is larger than in canines [13].

So far, according to the author's knowledge, no study has tried to analyse the GZP in different facial forms. In the present study an attempt was made to evaluate the difference between GZP in relation to VBM in different facial forms i.e. oval, square, square tapering and tapering form and also to look for the symmetry between maxillary central incisors of left and right side. There was statistical significant difference of GZP in relation to VBM of 11 and 21 teeth, between oval, square, square taper and taper face type. In addition, no significant differences were found when contralateral comparisons were made between two central incisors demonstrating symmetry of GZP AND VBM. Multiple comparisons between the facial forms revealed significant difference between square face with square tapering and tapering face. Clinically the position of GZP was coinciding with VBM in two cases of square tapering faces suggesting careful evaluation of GZP in such facial forms.

Smile design is an inseparable component of dentofacial esthetics, where gingival component plays a strong role. GZL is not uniformly displaced towards distal aspect in different facial forms. Clinicians may need to evaluate patients facial form and then decide to distalise the GZP in relation to VBM. This aspect finds application in smile enhancing procedures during implant placement, in restorative and surgical procedures.

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Tables

Table No1: Mean gingival zenith position (GZP) in relation to vertical bisected midline (VBM) of maxillary tooth in different faces.

Face Type	Minimum (mm)	Maximum (mm)	Mean ±S.D (mm)
Oval (n=52)	0.76	1.31	1.06±0.17
Square (n=52)	0.69	1.4	1.12±0.15
Square tapering (n=52)	0.61	1.35	1.04±0.17
Taper (n=52)	00	1.59	1.04±0.22

ANOVA	Sum of Squares	df	Mean Square	F	p value
Between Groups	0.243	3	0.081	2.804	0.041*

*significant as $p<0.05$.

Table No 2: Comparison of the gingival zenith position (GZP) in relation to vertical bisected midline (VBM) in between 11 and 21 teeth of different faces.

Face type		11 Tooth (mm)	21 Tooth (mm)	Paired differences		
				Mean difference	t	p value
Oval (n=26)	mean ± S.D	1.07±0.10	1.05±0.14	0.013	0.633	0.532(N.S)
Square (n=26)	mean ± S.D	1.11±0.14	1.13±0.17	-0.018	-0.647	0.524 (N.S)

Square taper (n=26)	mean ± S.D	1.05±0.14	1.03±0.19	0.023	0.882	0.386(N.S)
Taper (n=26)	mean ± S.D	1.06±0.14	1.02±0.3	0.034	0.847	0.405(N.S)

ANOVA		Sum of Squares	df	Mean Square	F	p value
11(right)	Between Groups	0.064	3	0.021	1.210	0.310
21(left)	Between Groups	0.198	3	0.067	1.614	0.191

Table No 3: Comparison of the gingival zenith position (GZP) in relation to vertical bisected midline (VBM) of maxillary tooth in between different faces.

Multiple Comparisons: Tukey HSD

(I) Face type	(J) Face type	Mean Difference (I-J)	p value
Oval	Square	-0.06 mm	0.056
	Square tapering	0.02 mm	0.553
	Taper	0.02 mm	0.585
Square	Square tapering	0.08mm	0.013*
	Taper	0.08 mm	0.014*
Square tapering	Taper	-0.02 mm	0.963

Table No 4: Multiple Comparison of the gingival zenith position (GZP) in relation to vertical bisected midline (VBM) of 11 tooth in between different faces.

Face type (I)	Face type (J)	Mean Difference (I-J)	p value
Oval	Square	-0.05	0.552
Oval	Square Tapering	0.01	0.979
Oval	Taper	0.008	0.997
Square	Square Tapering	0.06	0.321
Square	Taper	0.06	0.424
Square Tapering	Taper	-0.007	0.998

Table No 5: Multiple Comparison of the gingival zenith position (GZP) in relation to vertical bisected midline (VBM) of 21 tooth in between different faces.

Multiple Comparisons

Tukey HSD

Face type (I)	Face type (J)	Mean Difference (I-J)	p value
Oval	Square	-0.08	0.491
Oval	Square Tapering	0.03	0.970
Oval	Taper	0.03	0.956
Square	Square Tapering	0.1	0.250
Square	Taper	0.1	0.221
Square Tapering	Taper	0.004	1.000

Figure legends: Fig.1. Red line denoting GZP and black vertical line denoting VBM

Fig.2. Measurement of distance between GZP and VBM.

Fig.1

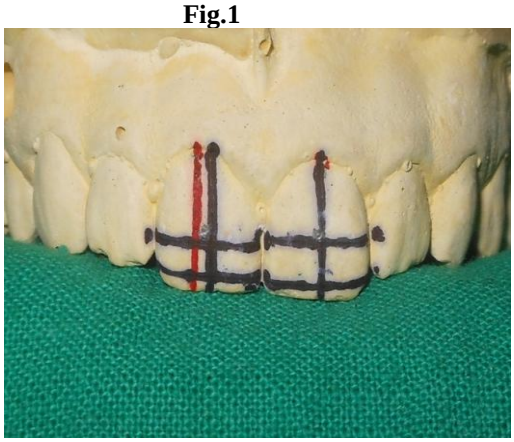

Fig.2