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AN EVALUATION OF CORRELATION BETWEEN THE GONIAL ANGLE AND FREEWAY SPACE IN DENTATE INDIVIDUALS

Dr. Mohini D. Panchal[1], Dr. Somil R. Mathur[2], Dr. Akanksha Trivedi[3], Dr. Sweta Ingale[4]

[1,4]Lecturer, Department of Prosthodontics, Faculty of Dental Science, Nadiad.
[2]Professor and Head, Department of Prosthodontics, Faculty of Dental Science, Nadiad.
[3]Reader, Department of Prosthodontics, Faculty of Dental Science, Nadiad.

Email: panchal.mohini@yahoo.com
Phone no.: 8320050357

ABSTRACT

The purpose of the present study is to establish a correlation between gonial angle and freeway space using lateral profilephotographs in dentulous individuals. The study includes a total of 150 participants within the age range of 20 – 30 years, of which one twenty-five were females and twenty-five were males. No restrictions were imposed withregard to the presence of malocclusion. The participants were informed about the study throughparticipant information sheet and signed consent was obtained. The study showed a mild negative correlation between Freeway space and gonial angle, indicating that when gonial angle increases freeway space decreases in both class I and class II participants. The study also showed that the freeway space was found to be more in Angle's class II dentate participantsThe study concludes that there was a statistically significant difference between freeway space between Angle'sClass I and Class II malocclusion. The freeway space in individuals with Angle's classII malocclusion was greater as compared to that with Angle's class I malocclusion. The gonial angle was observed to be more acute in participants with Angle's class II malocclusion as compared to that in participants with Angle's class 1 malocclusion. Lateral profile photographs can be used as a tool to predict freeway space in patients with Angle's class I malocclusion.

Keywords: *Gonial angle, freeway space, dentate individuals*

INTRODUCTION

The presence of freeway space is essential in dentulous subjects. It arises when the dentition erupts and initiates the sensory motor feedback mechanism.[1] This mechanism formsa memory trace in the central nervous system which helps in positioning the mandible in sucha way that it can close from its rest position into habitual occlusion with least interference from the cusps of the teeth , thereby optimizing the masticatory function.[1] The postural mechanismcoexists along with the sensorimotor feedback mechanism during dentate life and maintains itself again when the teeth are removed and the clinical rest position disappears.[1] The mandibular posture in edentulous state is primarily due to the gravitational force, this resting equilibrium is obtained with the elevator and depressor muscles.[2] It becomes clear, therefore,that both the upper and lower borders of the freeway space (the resting level and level of occlusal contact, respectively) are expressions of muscle function.[2] To do successful prosthodontic treatment it is essential to determine this freeway space.The freeway space remains constant throughout life in the dentulous as well as the edentulousphase. In the literature, there are various methods to determine freeway space like phonetics,[3] Niswonger's method,[1] No command, Transcutaneous electrical stimulation,[1] swallowing method,[2] Electromyography,[4] Tactile sense,[4] measurement of anatomical landmarks[3] etc.

Peter Potgieter et al. determined the freewayspace in edentulous subjects where gonial angle was obtained through lateral cephalograms.[2] D. N. Vinnakota et al. used lateral profile photographs for determination of freeway space and correlated it with the gonial angle.[1] Using cephalograms has its own drawbacks like picture deformation, superimpositions of structures, inaccuracy of cephalometric tracing and most importantly, radiation exposure due to cephalograms it might lead to inaccuracies in the results. These problems could be avoided using lateral profile photographs, where minor variations have minimal effectin points and angles marked on photographs. The variations observed in the study were negligible using photographs, especially because of introduction of standardisation in extraoral photography.[1]

Therefore an attempt has been made in this study to establish whether, photographs can act as an adjunct to predict the amount of freeway space in dentulous individuals with different malocclusions. Since freeway space remains constant, this study which is being doneon dentulous individuals, may be extrapolated for various other clinical scenarios as well.

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AIMS AND OBJECTIVES

To establish a correlation between gonial angle and freeway space using lateral profilephotographs in dentulous individuals.

Objectives:

1) Whether a correlation exists between gonial angle and freeway space in dentulousindividuals, and if extra oral photographs are a predictable tool for the same.
2) If a variation exists in this correlation between Angle's class I, II, III dentulous individuals.
3) Whether the freeway space varies in Angle's class I, II, and III dentulous individuals.
4) Whether the gonial angle varies in Angle's class I, II and III dentulous individuals.

Null Hypothesis

There is no correlation between the gonial angle and freeway space.

Methodology:

The study was conducted in the Department of Prosthodontics, Crown and Bridge Work and Oral Implantology in collaboration with the Department of Oral and Maxillofacial Pathology and Oral Microbiology, Dharmsinh Desai University Nadiad. The study was carried out with the approval from the Institutional Ethical panel.

Equipment used in the study

Camera: (Nikon D3300 24.2MP Digital SLR Camera, Nikon Corporation, Tokyo, Japan) Manual Vernier caliper (Yuzuki Vernier Calliper with fine Adjustment, 0 – 150mm/ 6 Inch,Moglix, Singapore.)

Protractor (Protractor, Kokuyo Camlin Ltd, Mumbai, India)

Materials used

- Thread
- Plaster slurry (Kalrock, Kalabhai Karson Pvt Ltd, India)
- Microtape (Neopore Surgical Paper, Medical Products Inc., New Delhi, India)Marker (Marker Pen, Kokuyo Camlin Ltd, Mumbai, India)

Sampling:

This study includes a total of 150 participants within the age range of 20 – 30 years, of which one twenty-five were females and twenty-five were males. No restrictions were imposed withregard to the presence of malocclusion. The participants were informed about the study throughparticipant information sheet and signed consent was obtained. The participants for the study were chosen on the basis of the following inclusion and exclusion criteria.

Inclusion criteria:

- Completely dentulous subjects with no missing teeth
- Good Neuromuscular Coordination
- Age group between 20 to 30 years

Exclusion criteria

- Subjects with signs and symptoms pointing towards TMD/MPDS.
- History of trauma, accident, injury to TMJ.
- History of plastic surgery in the head, neck and face region.
- Poor neuromuscular control.
- Musculoskeletal disorders.
- Facial Asymmetry.
- Orthodontically treated subjects.
- Subjects with Cleft lip and Cleft palate.
- Subjects with maxillofacial defects; congenital or post -surgery

This study involves determination of gonial angle using a lateral profile photograph and freeway space with the help of three different methods.

Determination of Gonial Angle using a Lateral profile photograph.

Lateral profiles were captured following the standards of extraoral photography using a Nikon D3300 SLR camera (Nikon D3300 24.2MP Digital SLR Camera, Nikon Corporation, Tokyo, Japan).

The following soft tissue reference points were chosen for thisstudy. (Illustration 1)

Porion (Stp)

Skin gnathion (Stgn)

Gonion (Stg)

The participant was positioned in a chair comfortably. A line was drawn, connecting the outercanthus of the eye and

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superior edge of the external auditory meatus with the help of a thread coated with plaster slurry. A line, perpendicular to this line was drawn and extended to the lower border of the mandible. The point gonion, was palpated by the left thumb and marked with a marker (Marker Pen, Kokuyo Camlin Ltd, Mumbai, India).Participant was instructed to stand for the photograph and position of the head in a natural position ensuring that the line connecting the outer canthus to superior edge of external auditory meatus is parallel to the red line marked on the wall. This ensured that all the participants had the same posture.All the norms of standard extraoral photography were followed. The photographs were taken from a distance of five feet. Formatting was done on the photographs and printed. All the softtissue reference points were marked on the printed photograph and joined to form the gonial angle (Stp-Stg-Stgn) (Illustration 2), which was measured with the help of a protractor. (Illustration 3)

Determination of Freeway space by clinical methods.

This was done by directing the patient to sit straight, with the head unsupported, with eyes looking far forward at a distance ensuring that the Frankfort's Horizontal plane is parallel to the floor. Following this, square pieces of adhesive tape (Neopore Surgical Paper, Medical Products Inc., New Delhi, India) were placed on the tip of the nose and the most prominent part of the chin. Using a manual Vernier Calliper (Manual Vernier caliper (Yuzuki Vernier Calliper with fine Adjustment, 0 – 150mm/ 6 Inch, Moglix, Singapore), (Illustration 5) the facial height of each participant was measured at the rest position, and then with the teeth in maximum intercuspation so the difference between these readings represents the freeway space.

The methods chosen for determining the rest position were:

- Phonetics method: to pronounce slowly the letter 'm' several times.
- Swallowing method:
- No command method:

Then asked to occlude in maximum intercuspation to determine the vertical dimension of occlusion. At the end of each stage, the distance between the two points was measured using a Vernier calliper. The following formula was used to calculate the freeway space. *Freeway space = Vertical dimension at rest – Vertical dimension at occlusion.*

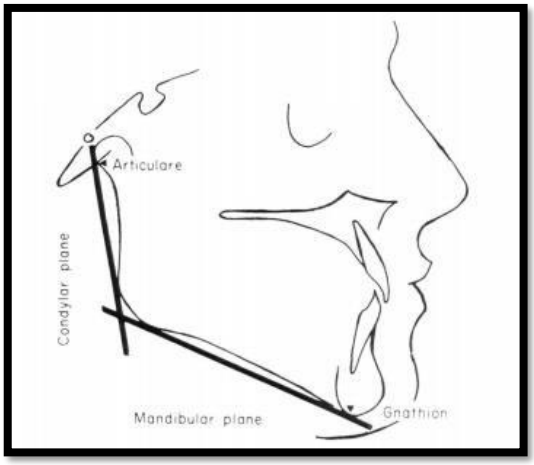

Illustration 1

The observations were statistically analyzed using SPSS version 23. Descriptive statistics for scale data Pearson correlation, linear regression analysis was done to assess the correlation of the calculated parameters.

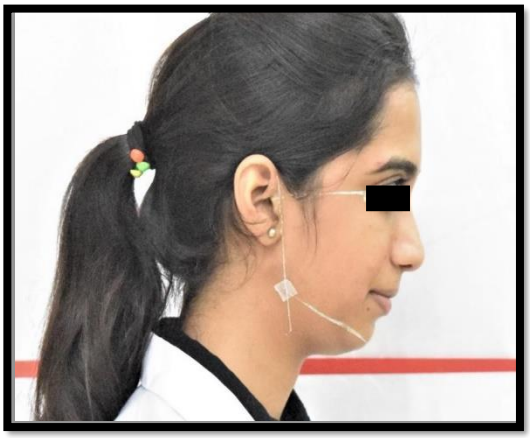

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Illustration 2

Illustration 3

Observation and Results

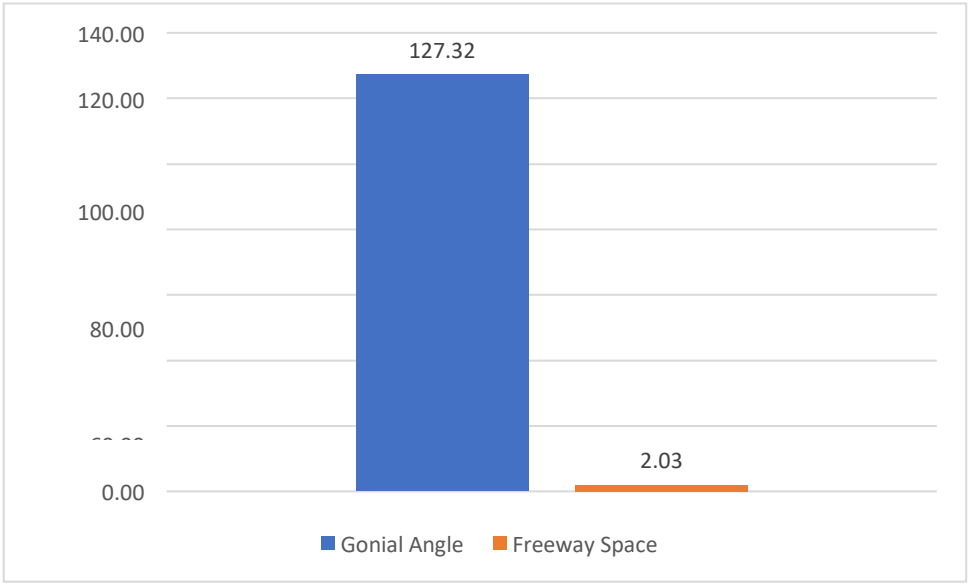
The gonial angle values obtained from the photographs which were measured with the help of a protractor and free-way space values obtained clinically in participants are listed in tables below.

X = gonial angle measurement (degrees).

Y = free-way space measurement (mm).

Figure and Graph shows the mean values of gonial angle and freeway space on graph. The mean value calculated was 125.32 for gonial angle and mean freeway space obtained through swallowing, phonetics and no command method was 2.0259 respectively.

Parameter	N	Minimum	Maximum	Mean	Std. Deviation
GonialAngle	150	102.0	146.0	125.315	5.9011
Freeway Space	150	0.55	4.51	2.0259	0.83655



Formulation of Hypothesis: Null Hypothesis: H0 = There is no correlation between Freewayspace and gonial angle. Alternate Hypothesis Ha = There is correlation between Freeway space and gonial angle, P value < 0.05 is considered as statistically significant. If P value < 0.05 we can reject the null hypothesis and consider the alternate hypothesis. Pearson's correlation coefficient was calculated in order to establish a correlation between two mathematical entities. Here, coefficient of correlation was calculated for the gonial angle(X) and freeway space (y). There was a statistically significant mild negative correlation between the gonial angle and freeway space, which indicates that when gonial angle increasesfreeway space decreases.

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2.2 Table 1: Correlation between freeway space and gonial angle

Correlation between		Freeway Space
GonialAngle	Pearson Correlation	-.25**
	Sig. (2-tailed)	**0.006***
	N	150

*-Statistically significant (p<0.05)

Correlation between freeway space and gonial angle in both (Angle's class I and class II malocclusion) Table shows that there was a mild negative correlationbetween Freeway space and gonial angle. It indicates that when gonial angle increases freeway space decreases in both the groups (Table 1).

3.2 Table 2: Correlation between Freeway space and Gonial angle

Group	Correlation between		Freeway Space
Class I	Gonial Angle	Pearson Correlation	**-.246****
		Sig. (2- tailed)	**0.009**
		N	33
Class II	Gonial Angle	Pearson Correlation	-0.063
		Sig. (2- tailed)	0.510
		N	35
**. Correlation is significant at the 0.01 level (2-tailed).			

The values calculated for Angle's class I malocclusion group were:Free way space = -0.018*,gonial angle = + 4.051. On substituting the value of the independent variable i.e gonial angle in the linear regression formula, freeway space value (x) was determined. Thus as this is a significant formula we can conclude it as the best formula for indication of freeway space using gonial angle in Angle's class I group. (p=0.009, r=0.324) (Table 3).

The values obtained for Angle's class II malocclusion group using linear regression formulawere : Free way space = -0.005*, gonial angle + 3.849. The freeway space obtained using theregression formula was not significant. As this is a not significant formula we cannot conclude it as the best formula for indication of freeway space using gonial angle in Angle's Class II malocclusion . (p=0.510, r=0.06) (Table 3)

4.2 Table 3: Regression model for both the groups

Coefficients[a]						
Group		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std.Error	Beta		
ClassI	(Constant)	4.051	0.855		4.640	<0.001**
	Gonial Angle	-0.018	0.005	-0.246	-2.651	0.009*
ClassII	(Constant)	3.849	2.446		1.554	0.125 NS
	Gonial Angle	-0.005	0.019	-0.063	-0.355	0.510 NS

Mean values of gonial angle and freeway space in Angle's class I and in class II malocclusiongroup calculated were 125.86 and 1.53; 125.66 and 2.93 respectively. There was statistically significant difference between freeway space and in Angle's class I and class II malocclusion group. The freeway space was found to be more in participants with Angle's class II malocclusion. No significant difference was found with respect to the gonial angle measurement in both groups (Table 4).

Table 4

Parameter	Class I		Class II		P value
	Mean	SD	Mean	SD	
Gonial Angle	125.86	8.14	125.66	6.95	0.354 NS
Freeway Space	1.53	0.61	2.93	0.80	<0.001**

NS- Not significant (p>0.05), **-Highly significant (p<0.001)

Mean values of gonial angle and freeway space in Angle's class I and class II groups wereplotted on a bar graph (Graph 2)

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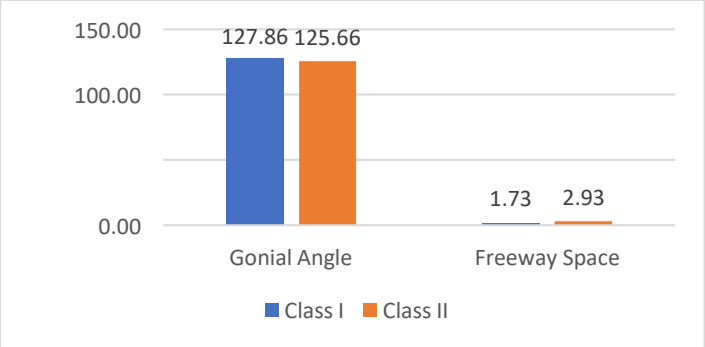

DISCUSSION

In the present study, the gonial angle and freeway space values were obtained using photographs and clinical assessment respectively. Pearson's coefficient has been used earlier to establish a correlation between these two mathematical entities. A statistically significant mild negative correlation between the gonial angle and freeway space was obtained, which indicates that when gonial angle increases freeway space decreases.

The increase in gonial angle occurs in older people, usually due to loss of teeth. J. A. Keen in his study on angle of mandible stated that in persons who retain their teeth did not show any tendency towards enlargement of the angle of mandible.[2] Potgieter stated that it is believed that the shape of mandible is influenced by the muscles of mastication, mainly by masseter and medial pterygoid which have their insertion onto the gonial angle.[2] When teeth are lost, the muscles tend to mold the mandible in a way that it restores parallelism of the bitingsurfaces, leading to an increase in the angle of mandible[2]. According to Ellie Jensen, gonial angle is dependent on the facial dimensions and varies from race to race Sprawson stated that the variation in the gonial angle is observed with the vertical deviations as well. This may be seenin cases with class II and class III malocclusion.[5] The gonial angle showed a tendency to be more acute in deep overbite, class II cases, while in class III cases with relatively smaller facialheight (due to shorter ramus), gonial angle was found to be acute and in longer facial height, more obtuse gonial angle was observed.[2]

Freeway space (FWS) or the interocclusal distance, is determined by the balance between the elevator and depressor muscles attached to the mandible.[2] The upper and lower borders of the freeway space are the expression of muscle function.[2]

FWS was described in two ways, adaptive and true FWS. The space that exists when the patient is instructed to voluntarily allow the jaw to relax is the adaptive space, whereas the one that is present after the relaxation of the masticatory musculature is the true FWS. However, the clinical rest position was not coincident with minimal muscle activity as proved in electromyographic and kinesiographic studies.[1] The FWS is affected by many factors; openingthe mouth for an extended period of time, as it happens during our clinical procedures, and chewing hard substances can have a profound effect. The muscles that control the mandible can also become tense when any type of mechanical recording device is placed in the mouth or on the head.[4]

As per the cephalometric studies conducted by Potgieter et al., in the Caucasian population for dentate patients using lateral cephalogram the gonial angle was found to be inversely correlated with the freeway space.[2] This is in agreement with the results observed inthis research work. Dileep Vinnakota et al. in his study also used lateral profile photographs as a substitute to lateral cephalogram for determination of gonial angle, considering the usage of lateral profile photograph for determining freeway space, however the results of this study showed a strong positive correlation between the gonial angle and freeway space in dentate participants.[6] This study however, also calculated the gonial angle of participants with the help of lateral cephalogram and then compared with lateral profile photographs Inspite of cephalometry using specific and predetermined points of bone references to obtain exact measurements, it has its own drawbacks like picture deformation, superimpositions of structures, inaccuracy of cephalometric tracing and most importantly, radiation exposure. These drawbacks may lead to inaccuracies in the results. These problems could be avoided using lateral profile photographs, where minor variations have minimal effectin points and angles marked on photographs.

This study showed a mild negative correlation between Freeway space and gonial angle, indicating that when gonial angle increases freeway space decreases in both class I andclass II participants. This study also showed that the freeway space was found to be more in Angle's class II dentate participants. This study is limited to a specific geographical area and population. Gonial angle variations have been observed in various racial groups.

CONCLUSION

Within the limitations of the study, the following conclusions can be derived:

1. There is mild negative correlation between freeway space and gonial angle. It indicatesthat when gonial angle increases freeway space decreases
2. The mathematical formula based on this significance: Y=aX+B, can be concluded as the best formula for indication of freeway space using gonial angle in Angle's class 1 malocclusion but not in subjects with Angle's class II

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malocclusion.

3. There was a statistically significant difference between freeway space between Angle's Class I and Class II malocclusion**.** The freeway space in individuals with Angle's classII malocclusion was greater as compared to that with Angle's class I malocclusion.
4. The gonial angle was observed to be more acute in participants with Angle's class II malocclusion as compared to that in participants with Angle's class 1 malocclusion.
5. Lateral profile photographs can be used as a tool to predict freeway space in patients with Angle's class I malocclusion.

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