

Research Paper: Investigating the Correlation Between Freeway Space and Gonial Angle Among Patients with Natural Dentition



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ABSTRACT

Introduction: Calculating the correct vertical relation between mandible and maxilla is considered to be a crucial element in successful placement of removable and fixed partial dentures.

Materials and Methods: This is an analytical study with cross-sectional conducted in 2018 on 128 patients to determine the correlation between FreeWay Space (FWS) and gonial angle. For measuring the correlation between them, their Vertical Dimension at Rest (VDR), Vertical Dimension of Occlusion (VDO), and Maximum Intercuspation Position (ICP) were recorded. The difference between VDR and VDO was reported as FWS. For measuring gonial angle, panoramic radiography method was used and data were analyzed using independent t-test and Pearson correlation test at a significance level of $P < 0.05$.

Results: The correlation coefficient between FWS and gonial angle, between FWS and age, and between gonial angle and age were reported as $r = -0.052$, 0.137 , and -0.102 , respectively. Furthermore, the significance level for the difference in FWS and gonial angle between men and women was found to be $P = 0.267$ and $P = 0.6$, respectively.

Conclusion: There was no significant relationship between FWS and gonial angle. Hence, gonial angle cannot be used for measuring the FWS.

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1. Introduction

One of the crucial factors for a successful placement of removable and fixed partial dentures is to achieve the right vertical relation between mandible and maxilla [1].

Freeway Space (FWS) is defined as calculating mutual coordination of muscles responsible for elevation and depression of mandible when it is not in contact with maxilla. Achieving FWS is an essential part of an ideal function of dental prostheses. In another definition, FWS is described as the difference in vertical distance between at rest position and maximum intercuspation position of the mandible [2].

When the FWS is less than normal range, muscles of mastication will be under a constant stimulus, resulting in a reflexive traction in muscles. This issue increases the muscular contractions and eventually leads to damage on teeth, periodontium, muscles of mastication, temporomandibular joint, and patient's restorations [3]. Moreover, a lower FWS creates problems in mucous membrane, causes muscle fatigue and results in problems regarding correct pronunciation. In case of an extra FWS, the patient's face appearance is affected and results in angular cheilitis [4]. An exact calculation of Vertical Dimension of Occlusion (VDO) is critical in cases with hypertrophic masseter muscles, alveolar sclerotic processes, and those who are brachycephalic [5]. If it is not chosen wisely, patients may face various problems [6]. Thus, for avoiding the mentioned complications, FWS and VDO must be determined carefully.

FWS can be different in various maxillomandibular relations [7]. The determination of FWS in short and long face subjects is of great importance, while gonial angle is less important in the former group, and more important in the latter group [8]. Comparing to an anatomical angle, gonial angle is defined as the junction of lower mandibular border and posterior border of ramus. It can be measured by using panoramic and lateral cephalometric radiographies. Moreover, it is not affected by edentulism [9].

Considering the importance of calculating FWS in a quick and precise prosthetic reconstruction and its effect on teeth, periodontium, and muscles of mastication [1], this study was aimed to explore the relation between FWS and gonial angle. Other purposes of this study are: Contradictory results in previous studies, lack of research on Iranian population, and availability and usability of panoramic radiography.

2. Materials and Methods

The present study (an analytical with cross-sectional design with ethical code of IR.GUMS.REC.1397) was conducted on 128 dentulous patients for whom panoramic radiography was already prescribed for various reasons. All the measurements were performed by a single prosthodontist and the exclusion criteria were as follows: having low quality radiography and position errors; a history of trauma and maxillofacial surgery; extensive abrasion in posterior and anterior teeth; lacking Maximum Intercuspation (MIC) in their posterior teeth; having systemic disease in muscles of mastication; severe periodontal problems; missing posterior teeth in one or both jaws resulting in distortion of MIC or making it impossible to measure; nasal airway obstruction; and deformations in head and face.

After obtaining patients' consents, using a copying pencil or a marker, one marker was placed on the tip of their nose and another on the outermost layer of the chin. Patients then were told to either sit upright or stand, while there was no headrest and they were told to look at the farthest point ahead of them (natural head position). They were told to relax and put their lips on each other while their teeth were not in contact with each other [10]. The distance between the two points was measured using calipers (Guanglu, Taizhou, China) with an accuracy of 0.1 mm.

All the measurements were performed in a quiet environment with the presence of the dentist and patient. The procedure was repeated three times and the average score was calculated and recorded as Vertical Dimension At Rest (VDR) [11]. Positioned as before, the VDO was recorded again while they were instructed to put their lips and teeth on each other. The difference between VDR and VDO was determined and recorded as FWS. All the radiography images were taken by CRANEX™ 3D (Soredex, Helsinki, Finland) in the faculty of dentistry with the right positioning and appropriate resolution and contrast (70 kvp, 10 Ma, 12s). Afterwards, considering the patients' radiography, gonial angle was measured by a protractor and was drawn on a tracing paper. The value for the left and right gonial angles, as well as their mean score were measured and recorded.

Collected data were analyzed using descriptive (frequency distribution, mean, standard deviation, median, maximum, and minimum) and inferential statistics (Pearson correlation coefficient and independent samples t-test) in SPSS V. 22 software.

3. Results

Participants were 128 patients (68 women, 60 men) with an average age of 33 referred to Guilan Faculty of Dentistry. The mean±SD of FWS was measured as 1.82±0.9 mm (ranges from 1 to 4 mm); and for gonial angle, it was 123±6 degrees (ranges from 106 to 137° degrees) as shown in Table 1.

The Pearson correlation test showed a weak and negative correlation between FWS and gonial angle among participants but it was not statistically significant ($r=-0.052$; $P=0.556$) as shown in Figure 1. Moreover, results revealed no statistically significant difference in FWS ($P=0.267$) and in gonial angle ($P=0.6$) between men and women (Figure 2 and 3). The relationship between age and FWS was found to be positive and weak but was not significant ($P=0.124$) (Figure 4). The relationship between age and gonial angle was negative and weak and was not significant either ($P=0.251$) (Figure 5).

4. Discussion

In this study, the possible correlation between FWS and gonial angle was investigated on 128 patients with an average age of 33 and age range of 20 to 70 years

(68 women and 60 men) referred to the Guilan Faculty of Dentistry located in Rasht, Iran in 2018. One of the important criteria for having success in placement of removable and fixed partial dentures is the correct calculation of the vertical relation between mandible and maxilla [1]. If the FWS be less than normal, muscles of mastication will be under a constant stimulus which eventually causes a negative effect on patient's teeth, periodontium, and joint. And if the FWS be more than normal range, the patient's face appearance will be negatively affected [3].

In this research, panoramic radiography was used for measuring the gonial angle. In the study of Pillai Devu and Masao Araki who used panoramic radiography and lateral cephalometry for determining the precision of gonial angle, the mentioned imaging methods did not show a significant difference [12, 13]. according to these studies and due to a more widespread prescription and use of panoramic radiography, the mean of right and left gonial angles was obtained by this method. For this analysis, a caliper was used for measuring FWS according to Geerts et al. who used both Willis gauge and caliper for vertical measurement and reported the caliper to be more reliable [14]. Based on the findings of the current study, no significant correlation was found between FWS and gonial angle.

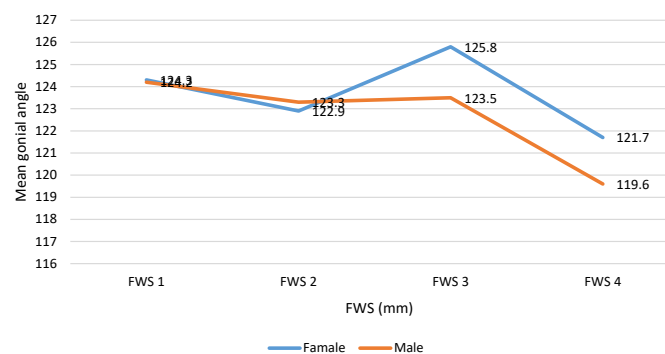


Figure 1. FWS vs. gonial angle among participants ($P>0.05$)

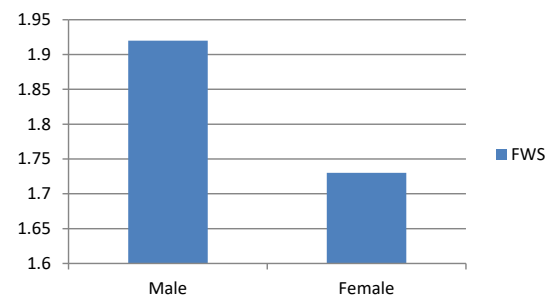


Figure 2. Comparing FWS between male and female samples ($P>0.05$)

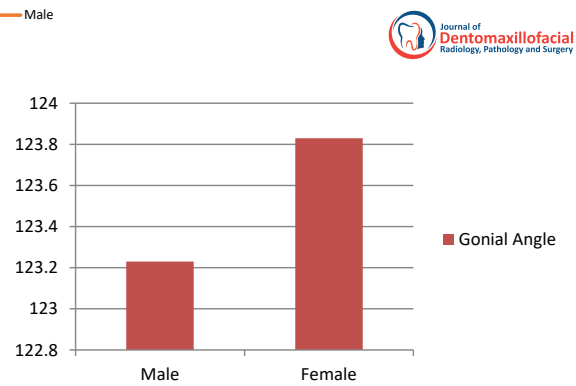


Figure 3. Comparing gonial angle between male and female samples ($P>0.05$)

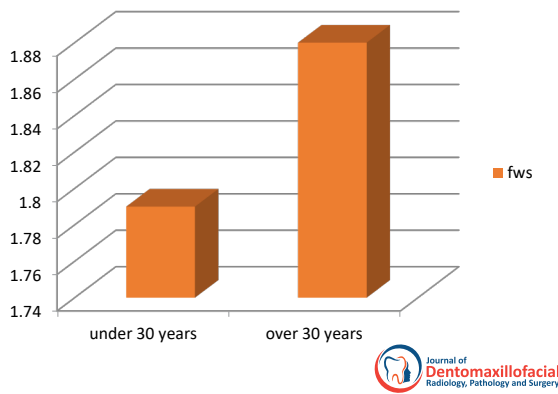


Figure 4. FWS vs. age factor among participants (P>0.05)

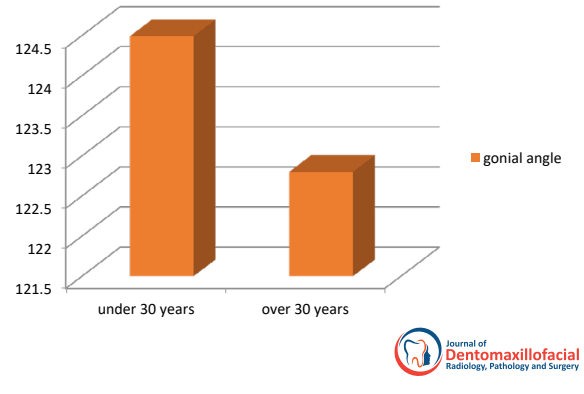


Figure 5. Gonial angle vs. age factor among participants (P>0.05)

Table 1. Summary of descriptive statistics of FWS and Gonial angle

Variable	Mean±SD	Minimum	Maximum
FWS (mm)	1.82± 0.958	1	4
Gonial angle (degree)	123.55± 6.56	106	137

Dileep Nag, Anusia, and Sherry et al. analyzed the correlation between FWS and gonial angle as well [2, 11, 15]. The first two studies came to similar conclusions which were against the results of Sherry et al. and the current study. Sherry et al. and Dileep studied dental and skeletal class 1 patients while in the present study and in Anusia’s study, skeletal patterns were not the subject of the study. On the other hand, various methods of measurements were used in all these four studies: Dileep used photography, whereas Sherry et al. and Anusia used lateral cephalometry as the method of measurement.

As it is known, measuring gonial angle based on the spots on bones in X-ray images is a more accurate method. Moreover, the statistical population of the current study was larger than the three above-mentioned studies (128 vs. 53 in Dileep’s, 20 in Sherry et al.’s, and 100 in Anusia’s). The age range was greater, as well (20-70 years vs. 27-70 years in Dileep and Sherry et al. and 18-48 years in Anusia’s). Although all these three studies reported the correlation between FWS and gonial angle as significant, the correlation direction was different. Anusia and Dileep reported it as negative while Sherry et al. reported positive. The discrepancy may be due to using different study procedure; Dileep and Sherry et al. had the same inclusion criteria (skeletal and dental class 1) and same age range; however, Anusia had emphasis on the great number of interfering factors. Thus, there is a need for further studies.

In some other series of tests, Bassi and Karine analyzed the relevance of cephalometric findings in measuring VDO and found paradoxical results [16, 17]. Bassi’s study is consistent with the present study. Based on Karine’s study, for determining VDO, cephalometric analysis can be used based on bone structures; however, only 31 lateral ceph were used in their study which was not enough for confirming such a claim (31 vs. 100 in Bassi’s and 128 in current study).

The inclusion criteria and age range were different as well. Karine entered dentulous people who had retained all their teeth (except third molars) and the age range was 18-48 years, while Bassi used edentulous subjects with an age range of 59 to 70 years. In the present study, only the dentulous people who had maximum intercuspation between their posterior teeth were used (age range, 20-70 years). Furthermore, study methods were different in these studies. Gonial angle was not directly and solely measured in their studies. Karine used upper and middle angles and suggested a formula called “Tavano” for calculating VDO and Bassi used mandibular, occlusal, and bisplanal planes.

Karine reported a significant relationship between cephalometric findings and VDO, whereas Bassi rejected such claim. Yamashita in a study to suggest a method for predicting VDO, concluded that when putting posterior teeth on each other, lower one-third of face has

a direct correlation with gonial angle [18]. Combining the results in their study and those in our study, it can be concluded that in patients with a more acute gonial angle, the VDR compared to VDO, is less than in typical patients and vice versa.

Based on the findings in the present study, no significant correlation was found between FWS and gonial angle. Considering the studies with opposing results, it can be said that methods for measuring VDR and psychological conditions and stress levels can be different at the time of measurement. According to Dawson and other researchers, the patient's own psychological condition and their level of calmness at the time of examination (amount of sleep the night before check-up and the commuting path) affect subject's composure and tonus of mandible elevation muscles [10, 19, 20]. All the mentioned factors can directly affect VDR and consequently FWS.

In the present study, people were examined regarding their level of tension before VDR and they were in a relaxed position at the time of measurement. One crucial factor to notice is that orbicularis oris and other muscles used to pucker the lips must be closed in an identical manner so that no factor can have indirect negative effect on measuring VDR and VDO. This is an important matter, since VDR and VDO measurements are made by spots that are marked on soft tissue of the patients, and in the present study, all patients were evaluated regarding this aspect.

5. Conclusion

It can be concluded that FWS and gonial angle are not significantly related with each other and gonial angle cannot be used for measuring the FWS.

Ethical Considerations

Compliance with ethical guidelines

There is no ethical principle to be considered doing this research.

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Authors contribution's

All authors contributed in preparing this article.

Conflict of interest

The authors declared no conflict of interest.

References

- [1] Alhaji M, Khalifa N, Abduo J, Amran A, Ismail I. Determination of occlusal vertical dimension for complete dentures patients: An updated review. *Journal of Oral Rehabilitation*. 2017; 44(11):896-907. [DOI:10.1111/joor.12522] [PMID]
- [2] Vinnakota DN, Kanneganti KC, Pulagam M, Karnati PKR. Freeway Space determination using lateral profile photographs: A pilot study. *The Journal of the Indian Prosthodontic Society*. 2016; 16(3):242-7. [DOI:10.4103/0972-4052.176528] [PMID] [PMCID]
- [3] Potgieter P, Monteith BD, Kemp PL. The determination of free-way space in edentulous patients: A cephalometric approach. *Journal of Oral Rehabilitation*. 1983; 10(4):283-93. [DOI:10.1111/j.1365-2842.1983.tb00123.x] [PMID]
- [4] Zarb GA, Bolender CL, Eckert S, Jacob R, Mericske-Stern R. *Prosthodontic treatment for edentulous patients*. Mosby: Elsevier Publications; 2004.
- [5] Koc D, Dogan A, Bek B. Bite force and influential factors on bite force measurements: A literature review. *European Journal of Dentistry*. 2010; 4(2):223-32. [DOI:10.1055/s-0039-1697833] [PMID] [PMCID]
- [6] Tripathi G, Ponnanna A, Rajwadha N, Chhaparia N, Sharma A, Anant M. Comparative evaluation of maximum bite force in dentulous and edentulous individuals with different facial forms. *Journal of Clinical and Diagnostic Research*. 2014; 8(9):ZC37. [DOI:10.7860/JCDR/2014/8801.4837] [PMID] [PMCID]
- [7] Hajimahmoudi M, Bahrami M, Nozarpoor S. Comparative Evaluation of the Inter-Occlusal-Distance and Closest Speaking Space in Different Angle's Occlusion Classes. *Dentistry Advances Research: DTAR-150*. 2018; 2018(2):1-10. [DOI:10.29011/2574-7347.100050]
- [8] Graber LW, Vanarsdall RL, Vig KW, Huang GJ. *Orthodontics-e-book: Current principles and techniques*. Edinburgh: Elsevier Health Sciences; 2016.
- [9] Shahabi M, Ramazanzadeh B-A, Mokhber N. Comparison between the external gonial angle in panoramic radiographs and lateral cephalograms of adult patients with Class I malocclusion. *Journal of Oral Science*. 2009; 51(3):425-9. [DOI:10.2334/josnusd.51.425] [PMID]
- [10] Dawson PE. *Functional Occlusion-E-Book: From TMJ to Smile Design*. Edinburgh: Elsevier Health Sciences; 2006.
- [11] Gupta A, Gambhir RS. Validity of cephalometric approach to determine Freeway Space in edentulous cases. *European Journal of Prosthodontics*. 2015; 3(2):32-5. [DOI:10.4103/2347-4610.157820]
- [12] Araki M, Kiyosaki T, Sato M, Kohinata K, Matsumoto K, Honda K. Comparative analysis of the gonial angle on lateral cephalometric radiographs and panoramic radiographs.

- Journal of Oral Science. 2015; 57(4):373-8. [DOI:10.2334/jos-nusd.57.373] [PMID]
- [13] Radhakrishnan PD, Varma S, Kovilakam N, Ajith VV. Dilemma of gonial angle measurement: Panoramic radiograph or lateral cephalogram. *Imaging Science in Dentistry*. 2017; 47(2):93-7. [DOI:10.5624/isd.2017.47.2.93] [PMID] [PMCID]
- [14] Geerts G, Stuhlinger M, Nel D. A comparison of the accuracy of two methods used by pre-doctoral students to measure vertical dimension. *The Journal of Prosthetic Dentistry*. 2004; 91(1):59-66. [DOI:10.1016/j.prosdent.2003.10.016] [PMID]
- [15] Sherry SA, Jain AR, Ariga P. Relevance of gonial angle as a determinant for Freeway Space in edentulous patients in South Indian population. *Journal of Pharmacy Research*. 2017; 11(12):1506-10.
- [16] Bassi F, Deregibus A, Previgliano V, Bracco P, Preti G. Evaluation of the utility of cephalometric parameters in constructing complete denture. Part I: Placement of posterior teeth. *Journal of Oral Rehabilitation*. 2001; 28(3):234-8. [DOI:10.1111/j.1365-2842.2001.00667.x] [PMID]
- [17] Tavano KT, Seraidarian PI, de Oliveira DD, Jansen WC. Determination of vertical dimension of occlusion in dentate patients by cephalometric analysis-pilot study. *Gerodontology*. 2012; 29(2):e297-e305. [DOI:10.1111/j.1741-2358.2011.00469.x] [PMID]
- [18] Yamashita S, Shimizu M, Katada H. A newly proposed method to predict optimum occlusal vertical dimension. *Journal of Prosthodontics*. 2015; 24(4):287-90. [DOI:10.1111/jopr.12223] [PMID]
- [19] Babu CS, Singh S, Rao S. Determination of vertical dimension of rest. A comparative study. *Journal of Prosthetic Dentistry*. 1987; 58(2):238-45. [DOI:10.1016/0022-3913(87)90184-3]
- [20] Makzoume JE. Variations in rest vertical dimension: Effects of standing posture in edentulous patients. *General Dentistry*. 2007; 55(3):228-31.