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Validity of cephalometric approach to determine freeway space in edentulous cases

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ABSTRACT

Aims and Objectives: The aim was to determine freeway space in edentulous individuals by correlating clinical findings of freeway space clinically with the gonial angle cephalometrically. **Materials and Methods:** The study was conducted on 100 dentulous individuals in the age-group of 20–30 years. Freeway space was determined by the difference between the readings of vertical dimension of rest and vertical dimension of occlusion in dentulous individuals. Gonial angle was calculated with the help of cephalometric radiographs, and the two were co-related. **Results:** Gonial angle (X) varied from 103° to 104° with an average of 122.45°. Freeway space (Y) ranged from 0.9 mm to 2.9 mm with an average of 1.77 mm. Co-relation of 51.21% existed between the gonial angle and freeway space. **Conclusion:** The study establishes a co-relation between gonial angle and freeway space with a value of 51.215%. In this way, the value of freeway space can be obtained.

KEY WORDS: Cephalometrics, freeway space, gonial angle, vertical dimension

Introduction

The concept of vertical dimension of occlusion (VDO) refers to a measure in the vertical plane that establishes the relation between the maxilla and the mandible when the posterior teeth, both from the maxillary and from the mandibular arches are occluded, regardless of whether they are natural or prosthetic, healthy or restored. This measure is subject to change, and when this occurs, it can compromise both the function and the facial aesthetics.[1]

Cephalometric roentgenography is highly sustained in the field of orthodontics and is presently being refined for outline use in prosthodontics. Number of clinical, as well as cephalometric methods, have been used to determine freeway space in edentulous as well as in dentulous individuals. It is frequently noticed that loss of teeth and supporting structure is followed by damage to the function of masticatory mechanism manifested as insufficient speech, poor esthetic and decreased comfort. Complete denture prosthesis aims at the masticatory restoration of the lost function. The provision of freeway space in fabrication of complete denture is one of the prerequisites.

Correct registration of occlusal vertical dimension has a biological importance as it allows the patient to be able to masticate his food efficiently, speak without impediment, keep his normal appearance and preserve temporomandibular joint function.[2] Both the upper and lower levels of freeway space (the resting level and occlusion contact level respectively) are expressions of muscle function.[3] Therefore in denture design it becomes vitally important that the level of tooth contact be set neither too high nor too low but at the precise level at which it will coincide with the onset of functional equilibrium.[4] Pyott and Schaeffer[4] revealed that if either two little or too great a freeway space in produced, undesirable symptoms will appear, classic among these are fractured artificial teeth, mid-line fracture in the restoration, discomfort, poor retention, loss of alveolar-ridges and sore tongue.

Loss of VDO, which causes a reduction of the lower face height and rotation of the mandible are some of the conditions, which may lead to obstructive sleep apnea. The role of complete dentures on modifications in the position

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of the jaw, tongue, soft tissues, and retropharyngeal space, thus precluding obstructive sleep apnea by restoring the lost vertical dimension correctly. An increasing vertical dimension (over opening) prevent muscular relaxation and decreasing vertical dimension (over closing) causes an over relaxed musculature. In either instance, neuromuscular tonus is disturbed.[5] Unfortunately, there is no method that measures correct point of inter-arch distance. Therefore, the present study was conducted to determine the validity of cephalometric approach to determine freeway space.

Materials and Methods

The study was conducted on 100 dentulous individuals, 48 male and 52 female in the age group of 20–30 years.[6,7] Ethical consideration was taken from the institutional review board. No sex variation was taken into consideration as gonial angle dimension are the same in male and female. The subjects selected had a full component of periodontally healthy and caries free teeth as any upset of these factor displays visible evidence of shortening of lower one-third of the face.[8] It was assured that no history of extraction of any teeth or any prematurity exists as these can give faulty readings of freeway space. We also checked that there was obvious symmetry in facial appearance.[9-11] The radiation dose experienced by the subjects during this procedure is very minimal and does not pose any threat toward the overall health of the patient.

Determination of freeway space

The individual was seated in the dental chair comfortably in an erect posture with the head well supported by the head rest. Subnasale was marked with a sharp, indelible pencil which looking at patients' profile (subnasale is the point where the lower border of the nasal septum meets the root of the upper lip). Gnathion, the point where the anterior border of the mandible join the lower border in the mid-line was marked with the help of an instrument.

The modified Vernier caliper was used to measure the distance between gnathion and subnasale, first at the level of rest position and then with the teeth into maximum intercuspation.[7,12,13] The difference between these two readings was taken as representing freeway space. The vertical dimension of rest (VDR) was recorded using the swallowing, phonetics and no command methods were used. The mean value resulting from the application of three separate methods of rest position determination was taken into account.[14]

Determination of the gonial angle

Lateral cephalometric radiographs were taken for all the cases by Siemens cephalostat.[1,15,16] The cephalometric films were exposed keeping a standard distance of five feet between the X-ray target and mid-sagittal plane of the head of the subject. The angle of the X-ray tube was kept at 90°. Just before exposure, the subject was instructed to swallow relax and bring the lips in approximation to secure the rest position of the mandible. After developing, the cephalograph were mounted on X-ray viewer and traced using acetate film.

The anatomical reference points gnathion (point where the anterior border of the mandible join the lower border as stated by scott 1967) and articulare (point of intersection between the posterior border of ramus and the base of the skull) were marked, two planes, mandibular plane (line tangent to the lower of the mandible and which passes through gnathion) and condylar plane, (line tangent to the posterior border of the mandible which passes through articulare) [Figure 1]. The angle thus formed by the intersection of these two planes is the gonial angle and is measured with a protractor to the nearest degree.

The gonial angle value determined cephalometrically in each case was paired with its respective freeway space value measured clinically and was subject to statistical analysis. Statistical analysis was done using SPSS package version 10 (SPSS Inc., Chicago, IL). Pearson's formula was used to determine the co-efficient of correlation (*r*). The data were statistically significant as *t*-test value was at 5% level of reliability.

Results

The gonial angle (X) ranged from 103° to 140° with an average of 122.46°. The freeway space, distance (X) ranged from 0.8 mm to 2.9 mm with an average of 1.77 mm, The mean of each reading was taken up by summing of the reading of X and Y then dividing each by 100 [Table 1].

Testing for co-efficient of correlation

Pearson's formula was used to determine the co-efficient of correlation (*r*), whose value was - 0.7156 which indicates a strong linear negative relationship between the two variables, further *t*-test was applied to determine its significance.

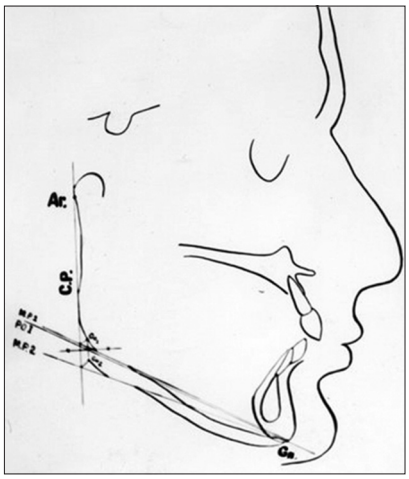

Figure 1: Anatomical reference points

Table 1: Range, mean, square and totals of reading X and Y

Reading	Range	Mean (mm)	Total of 100 readings	Total of square of 100 reading	Total
X	103-140	122.46	12,246	1,503,956 ΣX^2	21,493 $\Sigma X.Y$
Y	0.8-2.9	1.77	177.3	336.07 ΣY^2	

The data were statistically significant as *t*-test value was at 5% level of reliability. Coefficient of determination (R^2) was determined to find out the effect of X on Y. It shows that the value of X to Y is only 51.216%.

Discussion

There are various methods to record vertical dimension in patients. These range from using preextraction records to the use of swallowing, functionally acquired jaw positions associated with phonetics, and cephalometric radiographs and evaluation of radiopaque paste in the vestibular fornix.[15] There is no universally accepted or completely accurate method of determining the VDO in edentulous patients. There seem to be no significant advantages of one technique other than those of cost, time, and equipment requirements. It is the end result that matters.

The VDR has been determined by conventional methods using phonetic and swallowing methods.[6] Johnson *et al*. measured the freeway space of dentate subjects using a Willis gauge and secondly using a pair of sprung dividers; there was no significant difference between the two methods.[7]

A study was to compare the accuracy of the Willis gauge method with the caliper method. The Willis gauge was used to measures the distance between the septum of the nose and the chin. The caliper method measured the distance between reference points on the tip of the nose and the chin. The variances in the rest vertical dimension values for the Willis gauge method were higher than for the caliper method for most students.[13]

Variety of techniques used earlier was mostly directed towards the correct determination of VDO and having little concern with the freeway space. Correct determination of freeway space can be ascertained by trial and error with intelligent co-operation between the operator and patient.[17] The correlations found between freeway space, and gonial angle may be used as an aid in determining the value of free-way space. Thus in an edentulous patient where the value of freeway space is unknown, a method may be provided by predicting its best value by determining the patients gonial angle, through cephalometric analysis since the success of the denture is conditional on there being an adequate freeway space, so incorporation of correct amount of freeway space has long been recognized as a prerequisite for comfort and optimum function.

t-test was applied to the estimated value of freeway space, and gonial angle, and the result indicated that the parameter is significant at 5% level of significance. Thus, the level can be used for predicting freeway space for edentulous individual. These calculations have a practical value in that they provide a method to determine the best value of freeway space in cases where it is absent. Thus by obtaining the lateral cephalogram of an edentulous individual, the gonial angle may be readily assessed through the identification of the anatomical landmarks, that is, gonion, articulare, mandibular plane and condylar plane.[18]

Gender and age showed no significant effect on electromyography (EMG) activity in both muscles studied. Anterior temporal EMG activity recorded in the clinical rest position was significantly lower than in the VDO. This same EMG behavior was observed in the suprahyoid muscles, except during phonetic methods Mississippi and business.[14]

Study reports of some other author suggested that a jaw posture with a few millimeters of inter-occlusal distance involves a great reduction of masticatory muscle activity. By varying the vertical dimension millimeter by millimeter, masseter, and anterior temporal electromyographic activity demonstrated a considerable decrease over an inter-occlusal distance of 3–4 mm. Further mandibular opening up to 18 mm corresponded to small changes in postural activity.[19]

Some authors have presented a hypothesis that the amount of freeway space present in an individual is an expression of the masseter and medial pterygoid muscle.[13] They also have devised a method where by, through cephalometric analysis, the optimal amount of freeway space may be determined for an edentulous patient during denture construction. As there are no measuring of meaning muscle power readily accessible in a clinical context, and also the muscle power seems to vary inherently from individual to individual. Therefore, muscle force may be excluded as a mean of determining the extent of freeway space.

Conclusion

The study was conducted to find a correlation, if it exists, between the freeway space and gonial angle, which can provide a guide for determination of freeway space in edentulous cases. This study establishes a correlation between gonial angle and freeway space. In the present study, it has a value of 0.5121 that is 51.215%. The rest of the variation between the two was not explained by the fitted regression, indicating that there are some other factors, which affects freeway space. Therefore, it provides a method to determine freeway space is an edentulous case where its value is unknown. In order to extend the benefits to patients and dental practitioners, further studies should be undertaken to assess existing complete denture patients radiographically.

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