A cephalometric study to ascertain the use of nasion as a guide in locating the position of orbitale as an anterior reference point among a population of South Coastal Karnataka

Chethan Hegde, Nikhil J. Lobo, Krishna D. Prasad

Abstract

Context: To ascertain the use of nasion as a guide in locating the position of orbitale as an anterior reference point in the face-bow transfer records in individuals having different facial types. Aims: This study evaluated the distance from the nasion to the orbitale using cephalometric measurements to ascertain the use of nasion as a guide in locating the position of orbitale as an anterior reference point in individuals having different facial types among a population of South Coastal Karnataka. Subjects and Methods: Anthropometric measurements were made on 61 subjects and they were classified into mesoprosopic, euryprosopic and leptoprosopic facial type groups based upon the prosopic index. Lateral cephalometric radiographs were taken and nasion and orbitale distance was measured. The collected data was tabulated and statistically analyzed. Statistical Analysis Used: The statistical test carried out was the analysis of variance test and correlations were checked for using Pearson’s correlation test. Results: The study found the mean distance from nasion to orbitale was 24.25 mm with a standard deviation 4.26 mm. A good correlation was found between prosopic index and nasion to orbitale distance. No statistically significant variation in nasion to orbitale distance in individuals of different facial types was found. Conclusions: Although, variation exists it was not statistically significant. However, since a large range of measurements were found, prior evaluation using cephalometric radiographs may be necessary in certain individuals.

Keywords: Anterior reference point, face-bow, facial types, nasion, orbitale, prosopic

Introduction

Rehabilitation of the dentition requires fabrication of restorations in harmony with the functional movements of the mandible. Orientation of casts in an articulator is facilitated by using a face-bow to record the orientation of the maxillary arch relative to the patient’s cranial base.[1]

The value of mounting casts in an articulator is not limited to diagnosis it is of immeasurable value in all phases of dental treatment.[2,3]

The cast is positioned by identifying three points, two points located posteriorly and one anteriorly. The position recorded is reproducible permitting sequential mountings to be in the same anatomic relation.[4]

The posterior reference points utilized in a face-bow transfer procedure record the position of the mandibular transverse horizontal axis.[5]

The anterior point determines the plane of reference. Reproducibility requires a constant third point of reference. The orbitale can be used as an anterior reference point. Orbitale and the two posterior reference points will form the axis orbital plane.[4]

The nasion guide/positioner/relator of a face-bow fits into the nasion[6] depression locating the crossbar of the face-bow approximately in the region of the orbitale. The design of the nasion guide allows horizontal adjustment but not vertical from its attachment to the face-bow crossbar. Locating the orbitale using a fixed nasion relator is dependent upon the nasion notch morphology and the variance of distance from the nasion to the orbitale.[4]

The prosopic index classifies individuals into hypreuryprosopic (very broad face), euryprosopic (broad face), mesoprosopic (round face), leptoprosopic (long face), hyperleptoprosopic (very long face) based upon the ratio of the length of the face to the facial width.[7-9]

Variations in facial types are encountered in every population. Studies indicate ethnic variations in the face type among individuals.[8,9] The value of the using a fixed nasion relator in
a population with large variations is questionable as it may promote the development of inaccuracies in the prosthesis.\(^1,10,11\)

The purpose of this study was to determine the value of using nasion as a guide in locating the orbitale as an anterior reference point in face-bow records among individuals with mesoprosopic, euryprosopic and leptoprosopic facial types.

**Subjects and Methods**

The study was conducted on a patient population of South Coastal Karnataka visiting for treatment the A. B. Shetty Memorial Institute of Dental Sciences, Mangalore. A total of 61 subjects were selected, comprising individuals requiring lateral cephalogram as part of their treatment plan. Informed written consent was taken from each subject for their inclusion performing necessary investigations and use of the data.

Subjects included male and female patients, above 18 years of age, having no gross facial asymmetries and soft-tissues of the face free from congenital defects and deformities.

Subjects excluded from the study included individuals with history of fractures in the craniofacial region, history of surgery of the maxillofacial region, history/presence of fibro-osseous lesions affecting the facial structures.

Clearance from the Nitte University Ethical Committee was obtained to conduct the study.

Prosop sic index\(^7,8\) was used to classify subjects into the three study groups to evaluate facial type subjects were asked to sit on a chair in a relaxed condition with their head in anatomical position. Once the patient had achieved the physiologic rest position, nasion and gnathion were identified. Nasion was marked as the deepest part of the midline depression just below the level of the eyebrows.\(^4\) Gnathion was marked as the most inferior midline point on the mandible.\(^12\)

Measurements were made from nasion to gnathion and recorded in millimeters using vernier calipers [Figure 1]. Facial width was recorded as the distance between the zygomatic arches using bow callipers\(^13\) [Figure 2]. All the measurements were performed by one individual to avoid operator bias.

Prosop sic index was calculated for each subject using the formula\(^9,14\)

\[
\text{Prosop sic index} = \frac{\text{facial length} \times 100}{\text{facial width}}.
\]

Classification was based upon the Martin and Saller scale\(^13\) [Table 1]. Lateral cephalometric radiographs of each subject were taken on a cephalostat (PLANMECA 2002 CC Proline, exposure was at 68-70 kV, 12 mA) with the subject in the standard position for lateral cephalogram. Tracing was made by a single observer trained in cephalometrics. Cephalometric points and planes were marked on each of the tracings [Figure 3].
the tissue overlying the area of the frontonasal suture. The cephalometric planes of importance marked were – Frankfort horizontal plane – obtained by drawing a line connecting orbitale and porion. To determine the distance from soft-tissue nasion to orbitale, a perpendicular was drawn from the nasion to Frankfort horizontal plane and the length was measured in millimeters using a transparent scale, all measurements were rounded off to 0.1 mm. All measurements were corrected for radiographic distortion –1.10% enlargement.

The collected data was tabulated and statistically analyzed using the SPSS 15 software, the statistical test performed were the analysis of variance test and correlations were checked for using Pearson’s correlation test.

To check for intra-observer variability five randomly selected radiographs from the three study groups were given to the trained observer on five consecutive days. The observer was blinded. It was found that there was a high correlation between the measurements made by the observer on consecutive days.

Results

The results of the study found the mean distance of nasion to orbitale distance as 24.25 mm with a standard deviation 4.26 mm. The mean for the leptoprosopic group (25.56 mm), euryprosopic (23.63 mm) and mesoprosopic (23.59 mm) groups were calculated. The standard deviation was higher for the leptoprosopic group (4.77 mm) as compared with the euryprosopic (4.12 mm) and mesoprosopic (3.77 mm) groups. The statistical test used was the one-way analysis of variance test. Comparison indicated insignificant statistical difference ($F = 1.427$) ($P = 0.248$) in the mean of the three study groups [Table 2].

The mean facial length was found to be 108.69 mm with a standard deviation 6.125 mm. The mean facial width was found to be 126.31 mm with a standard deviation 6.503 mm. The mean prosopic index was found to be 86.00 mm with a standard deviation 4.25 mm [Table 3].

Correlations between nasion-orbitale values: Facial length, facial width and prosopic index values were evaluated using Pearson’s correlation test. The results of the test indicate that there is a poor positive correlation ($R = 0.124$) for facial length, a poor negative correlation ($R = −0.0068$) for facial width and a good positive correlation ($R = 0.203$) between prosopic index and nasion-orbitale value. The $P$ value for the correlations between facial length and nasion-orbitale values was (0.340), facial width and nasion-orbitale values was (0.604) and between prosopic index value and nasion-orbitale value was (0.117) indicating insignificant correlations [Table 4]. Correlations between nasion-orbitale values in individual groups were evaluated using the Pearson’s correlation test. The results of the test indicate that there is a negative good correlation ($R = −0.216$) for euryprosopic group, a positive good correlation ($R = −0.267$) for mesoprosopic group and a good positive correlation ($R = 0.282$) for leptoprosopic group. The $P$ value for correlations between euryprosopic group and nasion-orbitale values was (0.316), for mesoprosopic group and nasion-orbitale values was (0.242) and for leptoprosopic group and nasion-orbitale value was (0.228) indicating no significant correlation [Table 5].

Discussion

Orientation of casts within an articulator is the basic element in producing a realistic laboratory substitute for a patient. Snow is credited with the design of the traditional face-bow. Prior to this the maxillary cast placement in an articulator was arbitrary and merely a matter of mechanical convenience. Wadsworth introduced the concept of the third point of reference by the addition of the “$T$” attachment to the Snow face-bow, this was the first attempt to produce a three dimensional mounting of the maxillary cast in the articulator. Subsequent designs focused on identifying the horizontal axis points and the selection of an appropriate anterior reference point. Simon is believed to have first used the orbitale pointer, which utilized the orbitale as the anterior reference point.

### Table 1: Martin and Saller scale

| Group | Facial type | Range of prosopic index |
|-------|-------------|-------------------------|
| 1     | Mesoprosopic | 84.0-87.9               |
| 2     | Euryprosopic | 79.0-83.9               |
| 3     | Leptoprosopic | 88.0-92.9              |

### Table 2: Comparison of nasion-orbitale distance of the three study groups

| Study groups | N  | Mean | Std. deviation | Mean square | $F$ | Significant |
|--------------|----|------|----------------|-------------|-----|-------------|
| Euryprosopic | 20 | 23.63| 4.12           | 25.58       | 1.427| 0.248       |
| Mesoprosopic | 21 | 23.59| 3.77           |             |     |             |
| Leptoprosopic | 20 | 25.56| 4.77           |             |     |             |
| Total        | 61 | 24.25| 4.26           |             |     |             |
Hegde, et al.: Use of Nasion in locating the position of orbitale

Sicher[6] found that the nasion is located approximately 23 mm above the position of the orbitale. The nasion guide or nasal positioner may be designed to fit into this depression.[4]

Stuart[19] designed a face-bow that utilized the external auditory meatus for identification of the hinge axis and used a fixed value nasion relator (1 inch/25.4 mm) to approximate position of the orbitale. The features of his face-bow were unconventional for that period and the rationale for his designs have not been found.

It has been found through clinical experience that face-bows utilizing fixed value nasion relators often produce maxillary cast mountings with an occlusal plane position that is steep and noticeably misaligned relative to the cranial base.[1]

The selection of an appropriate anterior reference point has practical benefits as it allows both Dentist and the auxiliaries to visualize the cast in the articulator in the same plane of reference that would be used when looking at the patient.[4]

A variation in the distance from the nasion to orbitale in a patient while utilizing a face-bow with a fixed nasal relator can result in inaccuracies as the position of the reference plane was not appropriately determined due to the shortcomings of the face-bow assembly.

This may result in a final prosthesis with an inappropriately positioned occlusal plane, linguoverted maxillary anterior teeth, denture instability, decreased masticatory efficiency, damage to the supporting tissues. Additional implications include lack of common reference plane between mounted casts, clinical examination and cephalometric radiographs when planning orthognathic surgery.[1,4,10,20-23]

Studies done in numerous population shows variations in constituent parts of the face in individuals of different facial types. These variations although small may affect the accuracy of a face-bow transfer record where the nasion is used as a reference point to locate the position of the orbitale.[6,9,14]

Previous studies have found that the mean distance from the nasion to the orbitale can range from 26.8 mm to 30.0 mm. The range of values were found to be between 15.9 mm and 39.4 mm indicating large variations in the populations.[1,24] No absolute limit exists as to what constitutes an acceptable variation in the location of the anterior reference point.

In the present study, the aim was to investigate the reliability of using nasion as a guide in the location of the orbitale as the anterior reference point. It was based upon the assumption that in individuals of different facial types natural variations occurring in the distance of facial landmarks may affect the accurate determination of the anterior reference point for the face-bow transfer record.

This study found the mean nasion to orbitale measurement to 24.25 mm with a standard deviation of 4.26 mm. This is in agreement with other studies, which found the value of nasion to orbitale distance to be greater than the prescribed

| Parameters          | Mean (mm) | Standard deviation (mm) | N  |
|---------------------|-----------|-------------------------|----|
| Facial length       | 108.69    | 6.12                    | 61 |
| Facial width        | 126.31    | 6.50                    | 61 |
| Prosopic index      | 86.01     | 4.25                    | 61 |
| Nasion-orbitale     | 24.25     | 4.26                    | 61 |

![Table 3: Mean, standard deviation, total number of observations (n) for individual study parameters](image)

| Parameters          | Mean (mm) | Standard deviation (mm) | N  |
|---------------------|-----------|-------------------------|----|
| Facial length       | 108.69    | 6.12                    | 61 |
| Facial width        | 126.31    | 6.50                    | 61 |
| Prosopic index      | 86.01     | 4.25                    | 61 |
| Nasion-orbitale     | 24.25     | 4.26                    | 61 |

![Table 4: Correlations between nasion-orbitale distance and facial length, facial width and calculated prosopic index values](image)

| Parameters          | Mean (mm) | Standard deviation (mm) | N  |
|---------------------|-----------|-------------------------|----|
| Facial length       | 108.69    | 6.12                    | 61 |
| Facial width        | 126.31    | 6.50                    | 61 |
| Prosopic index      | 86.01     | 4.25                    | 61 |
| Nasion-orbitale     | 24.25     | 4.26                    | 61 |

![Table 5: Correlations of nasion-orbitale distance with prosopic index in leptoprosopic, euryprosopic and mesoprospocic groups](image)
23 mm. The obtained mean also differs from Stuart’s value of 25.4 mm.\textsuperscript{[1,24]}

The clinical implications of deviations are dependent upon the clinician and the procedure for which the maxillary cast is being mounted. A 1.25 mm difference in nasion to orbitale distance may seem irrelevant as a majority of patients will be concentrated around the mean. However, a large variation in measurement of nasion to orbitale distance with a range from 16.82 mm to 31.65 mm was found. The wide range may have profound implications on occlusal plane angulation for those subjects in the extremes of the population.

A fixed nasion relator that is too short for a given patient results in an opposite error in the cast mounting leaving the anterior point positioned too low and the resulting occlusal plane too steep. In case of a relator that is too long for a given patient, the mounting would be too high and the occlusal plane will be positioned shallower.\textsuperscript{[1]}

For individuals closer to two standard deviations above the mean, a vertical error as large as 8.52 mm can occur when compared to the prescribed dimension of 23 mm. This situation would account for a small, but none the less important portion of the population.

The study also determined whether facial length, facial width, and prosopic index had any correlation to the nasion to orbitale measurement.

The values for mean facial height and facial width are in agreement with other studies done on the Indian population.\textsuperscript{[14]}

Correlations between nasion-orbitale values: Facial length, facial width, and prosopic index were determined. It was found that as the value of the facial length and prosopic index increases the value of nasion to orbitale distance increases as the value of the facial width increases the value of nasion to orbitale distance decreases. Although a good correlation exists between the facial length, prosopic index and nasion to orbitale measurement they were statistically insignificant.

Prosocpic index is dependent upon the values of facial length and facial width. For a given facial length, varying facial width would result in the subjects being classified into different facial groups. Since nasion-orbitale measurement is a vertical distance measured along the length of the face, it may be assumed that facial length is of greatest value in determining the nasion to orbitale distance.

The study determined the correlations of nasion-orbitale values with prosopic index in individual groups. It was found that although a positive good correlation exists in the leptoprosoptic and mesoprosoptic group the correlation was statistically insignificant.

Selection of the horizontal plane of reference affects the nasion-orbitale measurement. Gonzales and Gonzales and Kingery,\textsuperscript{[25]} Pitchford\textsuperscript{[26]} have highlighted this fact and suggested methods to obtain more accurate mountings in an articulator-face-bow system having a fixed value nasal relator.\textsuperscript{[19]}

Small errors may not seem significant; however, the accumulation of these and the addition of errors in technique sensitivity and selection of the preferred plane question the use of a fixed value nasion relator. This is especially important in cases where orthognatic surgery is being planned.\textsuperscript{[26,27]}

The limitations include the lack of comparison between individuals of different genders as well as the exclusion of hypereuryprosopic and hyperleptoprosoptic individuals in the study, these groups which represent the extremes of the population will have significant larger variations from the mean.

The mean distance from nasion to orbitale for a population of South Coastal Karnataka was 24.25 mm. Poor correlation was found to exist between the length or width of the face and distance from nasion to orbitale. Good positive correlation was found between the prosopic index and distance from nasion to orbitale. No statistically significant variation in nasion to orbitale distance in individuals with mesoprosoptic, leptoprosoptic and euryprosoptic facial types was determined.

This study, unlike previous studies\textsuperscript{[24]} on the Indian population found that although variation exists it was not statistically significant. However, since a large range of measurements were found for nasion to orbitale distance the study recommends that prior evaluation using cephalometric radiographs could be done in leptoprosoptic individuals and if a variation is found to exist an alternate face-bow-articulator assembly which incorporates orbitale pointer to locate the position of the anterior reference point be used.

Since no absolute value exists as to what deviation from the mean will significantly affect the orientation jaw relation, further studies evaluating this parameter will be necessary.

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