

Evaluation of accuracy of transfer of the maxillary occlusal cant of two articulators using two facebow/semi-adjustable articulator systems: An *in vivo* study

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Abstract

Aim: The aim of this study was to compare the accuracy of the angle made by Frankfort horizontal plane-occlusal plane on maxillary casts, mounted using the respective facebows on Artex Amann Girsch and Hanau Wide-vue semi-adjustable articulators with cephalometrically derived Frankfort horizontal plane-occlusal plane angle as a control. **Subjects and Methods:** Maxillary casts of 30 subjects were mounted on Hanau Wide-vue and Artex Amann Girsch semi-adjustable articulators following facebow transfer using respective facebows. The Frankfort horizontal plane-occlusal plane angles of these casts were measured using Wixey's digital angle gauge. They were also subjected to a lateral cephalogram, and the occlusal cant was measured using RadiAnt DICOM software. **Statistical Analysis:** Using Pearson correlation, the accuracy of the angle made by upper member of the articulator and occlusal plane of mounted maxillary casts in each of the articulator was compared to the Frankfort horizontal plane-occlusal plane angle in lateral cephalogram. **Results:** A mean difference of 1.9° was found between Hanau Wide-vue articulator and lateral cephalogram and a mean difference of 3.6° was found between Artex Amann Girsch articulator and lateral cephalogram. Statistically, Pearson correlation value (*r*) obtained between Hanau Wide-vue and lateral cephalogram was 0.46 and between Artex Amann Girsch and lateral cephalogram was 0.25. **Conclusion:** From the statistical value (*r*) derived, it can be inferred that the Frankfort horizontal plane-occlusal plane angle of the casts articulated on Hanau Wide-vue articulator was more accurate in comparison to that on Artex Amann Girsch articulator.

Key Words: Articulator, facebow, Frankfort horizontal plane, lateral cephalogram, occlusal plane

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INTRODUCTION

One of the salient factors that help us in developing an occlusion that is compatible with the functional movement of the stomatognathic system is the orientation of occlusal plane.^[1]

The three dimensional spatial relationship of maxillary cast to the cranial structures is replicated to the articulator through a facebow. To orient the maxillary arch and dentition using a facebow, involves a plane of reference. The most

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common plane used as a reference for the facebow transfer is the Frankfort horizontal plane (porion-orbitale), which appears horizontal when the head is placed in the natural head position. Even the articulators are designed with an assumption of parallelism between the Frankfort horizontal plane and the upper member of the articulator. The plane is also used for “natural” orientation of head for cephalometric films.^[2] Clinicians have stated that a proper selection of a third point of reference on a Frankfort horizontal plane is essential in prosthetic procedures for the establishment of a correct plane of occlusion. This point is said to orient the maxillary cast to the upper member of the articulator as the maxillae are oriented to the Frankfort horizontal plane.^[3] The position of the occlusal plane in the patient and the articulator is an essential link for achieving the functional and esthetic goals of treatment.^[4]

If the maxillary cast is positioned in articulator without correct maxilla-hinge axis relationship, opening and closing movements in the articulator will not mimic the movements of the patient. An occlusion that is reinstated to an incorrect arc of closure or opening will show interceptive and deflective tooth contacts. Such contacts are unwelcome in both natural and artificial occlusions, and they can lead to temporomandibular joint pain, muscle spasm, and periodontal problems. Hence the need for a proper selection of anterior reference point which will help to orient the maxillary cast accurately in the articulator.

The accuracy of the orientation of the occlusal plane of maxillary cast to the articulator through facebow transfer can be accessed by comparing with the angle formed by the Frankfort horizontal plane-occlusal plane in a lateral cephalogram. A lateral cephalogram reveals areas in a cranial base that are not subjected to alteration, hence it is considered to serve as a very useful diagnostic tool. It is used in identifying predictable relationships between the teeth and other cranial landmarks that are not subject to post extraction changes, henceforth lateral cephalogram is considered as the gold standard.^[5]

Spring-Bow Hanau and Rotofix Artex facebows used in this study have distinct differences in the principles of transfer with regards to the third point of reference. An attempt is made in this study to compare the accuracy of the angle made by Frankfort horizontal plane-occlusal plane on maxillary cast, mounted on Artex Amann Girschbach articulator using Rotofix Artex facebow which uses nasion as the third point of reference and Hanau Wide-vue articulator using Spring-Bow Hanau facebow which uses orbitale as the third point reference with cephalometrically derived Frankfort horizontal plane-occlusal plane angle.

SUBJECTS AND METHODS

The study was carried out on 30 subjects comprising both males and females.

Inclusion criteria

- Subjects from Yenepoya University
- Age group: 18–25 years in which facial growth has completed
- Full complement of healthy and natural teeth
- No history of orthodontic movement.

Exclusion criteria

- Periodontally compromised teeth
- Teeth grossly attrited or abraded
- Presence of fixed or removable partial dentures
- Gross malalignment of teeth
- Missing teeth.

Subjects were randomly selected from students of Yenepoya University. Ethical approval for this study was obtained from the Research Ethics Committee of the Yenepoya University. The subjects voluntarily agreed to participate in the study after that the outline of the proposed research were distributed to them in a subject information/consent sheet. The study was completed in 1½ years.

The study was done in two parts:

In the first part, two maxillary impressions were made of each of the subjects using a stock tray with alginate. The impressions were poured in Type III dental stone. For each of the 30 subjects, the facebow records were made with Rotofix Artex and Spring-Bow Hanau facebows [Figure 1]. The facebow recordings were registered, and the maxillary casts were mounted on their respective articulators following the manufactures instructions.

Placing the incisal guide pin in contact with the incisal table, the custom made plate [Figure 2] was placed on the



Figure 1: Facebow transfer with Rotofix Artex and Spring-Bow Hanau facebows

occlusal surface of mounted maxillary cast in flush plane, contacting the incisal tip of central incisor, and mesiopalatal cusp of maxillary first molar. The angle formed by the upper member of the articulator and the custom made plate was measured using, Wixey's digital angle gauge [Figure 3] positioned on the plate. Wixey™ model WR365 digital angle gauge. Manufacturer: Barry Wixey Development, 5306 Umbrella Pool Road, Sanibel, Florida 33957. Has a flip up display pannel and magnetic base. Size: 2.2" × 2.3" × 1.3". Resolution: 0.1°. Range: ±180°. The angle measurement for each subject mounted on the Artex Amann Girrback and Hanau Wide-vue articulators were noted, respectively [Figure 2].

In the second part of the study, the lateral cephalograms of all the 30 subjects were taken with Frankfort horizontal plane parallel to the ground in a cephalostat. All the lateral cephalometric radiographs were shot by the standardized Planmeca Promax Cephalostat machine on a standard Kodak C-Mat Green Sensitive 8" × 10" film. Exposure parameters were set at 70 kvp, 10 mA, and 1 s. The direction of ray entry was from left to right. Using RadiAnt DICOM NX 2.0.8400 software, Built 7.0.1102, Agfa Healthcare N.V. Septestraat 27 software, the angle formed between Frankfort horizontal plane (porion-orbitale) and occlusal plane (a line drawn joining the incisal tip and mesiopalatal cusp of maxillary first molar) were measured [Figure 4a-c].

RESULTS

Table I reveals that in Hanau Wide-vue group the Frankfort horizontal plane-occlusal plane angle varied from a maximum of 15° to a minimum of 5.1° with a mean of $10.69^\circ \pm 2.44^\circ$. In Artex Amann Girrback group, the Frankfort horizontal plane-occlusal plane angle varied from a maximum of 11.5° to a minimum of 1.9° with a mean of $5.16^\circ \pm 2.27^\circ$ and for lateral cephalogram the Frankfort horizontal plane-occlusal plane angle varied from a maximum of 13.3° to a minimum of 3.5° with a mean of $8.7^\circ \pm 2.24^\circ$ [Table I].

Using Pearson correlation, the accuracy of the angle made by the upper member of articulator and occlusal plane of mounted maxillary casts in each of the articulator was compared to the Frankfort horizontal plane-occlusal plane angle in lateral cephalogram, that is, the gold standard. The correlation value (Pearson's *r*) obtained between Hanau Wide-vue and lateral cephalogram was 0.46 and between Artex Amann Girrback and lateral cephalogram was 0.25. Hence, it can be assumed that Hanau Wide-vue articulator is comparatively more accurate to Artex Amann Girrback as in agreement to the values obtained by Pearson correlation [Table 2].

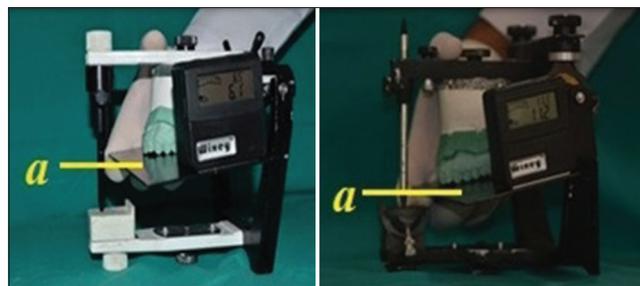


Figure 2: Frankfort horizontal plane-occlusal plane angle measured on mounted cast on Artex Amann Girrback and Hanau Wide-vue articulators using Wixey's digital angle gauge. Insert (a) shows custom made plate



Figure 3: Wixey's digital angle gauge

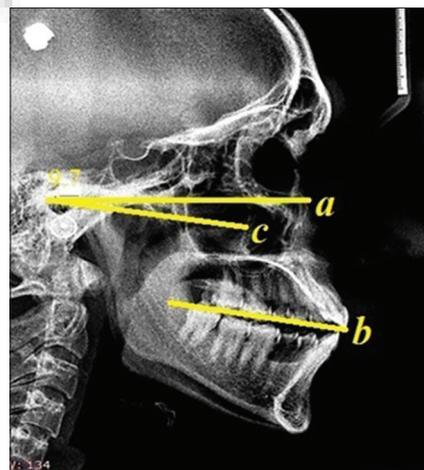


Figure 4: Pictorial representation of the angle formed between Frankfort horizontal Plane (a) Occlusal, Plane (b) measured using RadiAnt DICOM software on a cephalogram. Insert (c) represents a parallel line to insert (b)

DISCUSSION

An improperly selected occlusal plane may result in denture instability and decreased masticatory efficiency. Failure to accurately transfer the antero-posterior relationship of maxillary

Table 1: The mean and SD measures of Frankfort horizontal plane-occlusal plane angle derived from Hanau Wide-Vue articulator, Artex Amann Girrback articulator and lateral cephalogram

	n	Minimum angle	Maximum angle	Mean	SD
Hanau	30	5.1	15.0	10.687	2.4352
Artex	30	1.9	11.5	5.160	2.2736
Cephalogram	30	3.5	13.3	8.737	2.2429

SD: Standard deviation

Table 2: The correlation of the angle made by upper member of the articulator and occlusal plane of mounted maxillary casts in Hanau Wide-Vue and Artex Amann Girrback articulators with Frankfort horizontal plane-occlusal plane in lateral cephalogram

Type of articulator	Statistical test	Lateral cephalogram
	Number of subjects	30
Hanau Wide-Vue	Pearson correlation (r)	0.464
Artex Amann Girrback	Pearson correlation (r)	0.253

occlusal cant to the articulator can result in a substantial error in the final occlusion of prosthesis, while failure to transfer the correct vertical relationship can result in poor aesthetics. In both complete dentures and fixed partial dentures, failure to transfer the anterior reference point can result in an unnatural axial inclination of the maxillary anterior teeth. If the vertical positioning error is large enough, balancing side occlusal errors are produced in complete dentures, and with fixed partial dentures, the same error would produce non-working occlusal interference.^[6] Hence, it is imperative to have a facebow transfer.

The basic reference plane used for facebow transfer is Frankfort horizontal plane. A planned choice of an anterior reference point will allow the dentist and auxiliaries to visualize the anterior teeth and the occlusion in the articulator in the same frame of reference that would be used when looking at a patient. Mounting the maxillary cast relative to the Frankfort horizontal plane will accomplish the objective to have a natural appearance in form and position of anterior teeth. It is universally accepted that upper arm of the articulator represents Frankfort horizontal plane.^[7]

In the thirty subjects studied, it was seen that the Frankfort horizontal plane-occlusal plane angle of maxillary cast mounted using Spring-Bow Hanau facebow on Hanau Wide-vue articulator was more accurate than casts mounted using Rotofix Artex facebow on Artex Amann Girrback articulator when compared with the control, cephalometric occlusal cant.

The reason for the difference between the two facebows could be due to the position of the third point of reference in a vertical plane. Spring-Bow Hanau facebow uses orbitale as the anterior reference point. According to Wilkie,^[8] relating the maxillae to the axis-orbital plane will lower the maxillary casts anteriorly from the position that would be established

if Frankfort horizontal plane was used. Therefore, when the maxillary casts are mounted, the incisal edges of the maxillary casts are positioned more inferiorly, increasing the occlusal cant. In Rotofix Artex facebow, the crossbar is located 23 mm below the midpoint of the nasion positioned. Hence, the cross bar will be too low from the orbitale which tends to flatten the occlusal plane on the articulator. This could be the reason for flattening of the occlusal plane of the cast when mounted on Artex Amann Girrback articulator.^[9]

In our study, it was seen that with both Hanau Wide-vue and Artex Amann Girrback articulators, the Frankfort horizontal plane-occlusal plane angle of the mounted maxillary casts after facebow transfer did not exactly match the Frankfort horizontal plane-occlusal plane angle on the lateral cephalogram. A mean difference of 3.6° was found between the sagittal inclination of maxillary casts mounted on Artex Amann Girrback articulator and lateral cephalogram. This is in accordance with the study of Ramasamy *et al.*,^[9] who in their study achieved a similar mean difference of 3° inclination of occlusal plane of casts mounted on Artex articulator using a facebow with a fixed value nasion indicator.

This study showed a mean difference of 1.9° between the sagittal inclination of Hanau Wide-vue articulator and lateral cephalogram. This result is similar to the results got by Nazir *et al.*,^[6] who after their study reported a mean difference of 1.161° between the occlusal cant measured on Hanau Wide-vue articulator and lateral cephalogram.

The mean angle (10.69°) of sagittal inclination of maxillary cast mounted on Hanau Wide-vue articulator found in this study is not in accordance with the study conducted by Mohammad Abdullah and Sherfudhin,^[10] who in their study got a mean angle of 13.77°.

Thus after discussing the result of the study and within the research limitations, we can conclude that the Frankfort horizontal plane-maxillary occlusal plane relationship that exists in a subject is not transferred to the Artex Amann Girrback articulator by Rotofix Artex facebow as accurately as that by the Hanau Wide-vue articulator using Spring-Bow Hanau facebow.

CONCLUSION

- On the basis of results, the following conclusions are drawn:
- A mean value of 8.70 is recorded for the Frankfort horizontal plane-occlusal plane angle measured on lateral cephalograms of 30 subjects
 - A mean value of 10.60 is recorded for the occlusal plane angle of maxillary casts of 30 subjects mounted on Hanau

Wide-vue articulator, which is greater than the angle measured on the lateral cephalogram by 1.90

- A mean value of 5.10 is recorded for the occlusal plane angle of maxillary casts of 30 subjects mounted on Artex Amann GIRRbach articulator, which is lesser than the angle measured on the lateral cephalogram by 3.60
- The correlation value (Pearson's r) obtained between maxillary cast mounted on Hanau Wide-vue articulator and lateral cephalogram (0.46) is greater compared to the maxillary cast mounted on Artex amann GIRRbach articulator and lateral cephalogram (0.25). Thus, it can be concluded that the occlusal plane angle of maxillary casts mounted on Hanau Wide-vue articulator is more accurate than that on Artex Amann GIRRbach articulator.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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