



Evaluation of Two Facebow/Semi-adjustable Articulator Systems for Orienting Maxillary Cast on Articulators: A Pilot Study

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ABSTRACT

Aim: The present study was aimed to assess the transferability of occlusal plane (OP) orientation from the patient to the articulators with the help of two different facebow systems and evaluated with a gold standard.

Materials and methods: Twenty dentate patients were selected for the study. Two semi-adjustable arcon articulators that are Hanau Wide[®] Vue using SpringBow and Whip Mix[®] using quickmount facebow were used in the study. Mean angle between OP to horizontal reference plane obtained from Hanau Wide Vue articulator system (SpringBow using Orbitale as anterior reference point) and Whip Mix articulator system (quickmount facebow using nasion as anterior reference point) was tabulated. These values obtained were further compared with each other and evaluated against cephalometric evidence, which was considered as the gold standard for the study. Descriptive statistics, analysis of variance, Scheffe *post hoc* analysis for group comparison, and level of significance (P) was calculated using Statistical Package for the Social Sciences version 16 (IBM, New York, USA) software program.

Results: Intragroup comparison of mean angle OP values showed highly significant difference ($p=0.000$). Comparison between Hanau Wide Vue articulator system and Whip Mix articulator system showed statistically highly significant with a mean difference of 10.51° with Hanau system values being lower than Whip Mix system. Difference between Hanau system and cephalometric values were statistically significant with a mean difference of 2.835° and Hanau system consistently recording lower values than cephalometric values. Difference between Whip Mix system and cephalometric values was also statistically significant with a mean difference of 7.680° with group 2 values were on average 7.680° higher than group 3.

Conclusion: Within the limitations of this study, the Hanau system and Whip Mix system showed significant difference in reproduction of angle between OP and horizontal reference plane. Hanau articulator system showed closer values to that of cephalometric values in comparison with Whip Mix articulator system.

Clinical significance: Orientation of the maxillary cast in an articulator is a crucial part of several techniques used in dentistry. Orientation of maxillary cast in the articulator acts as a baseline from which further steps for occlusal rehabilitation of the patients are carried out. Recording and transferring of the occlusal cant to articulators require facebow.

Keywords: Arcon articulator, Cephalometric tracing, Facebow, Occlusal plane, Semi-adjustable articulator.

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INTRODUCTION

Articulators are said to be the mechanical equivalents for temporomandibular joint and jaws. They help replicate the biomechanical interactions between occlusal determinants as found in the stomatognathic system. Fully adjustable articulators can be programmed for dynamic movements of the jaw, but these articulators are technique- and operator-sensitive and hence semi-adjustable articulators

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are said to be the fairer and most commonly used substitutes. Semi-adjustable articulators are programmed using static records to replicate dynamic movements of the jaw, and hence it is important to recognize the articulators' capability for precision.

One of the occlusal determinants that have to be replicated by the articulator system is the occlusal plane (OP). Replication of OP by the articulator with the help of its facebow system as close to what is found in the patient is a necessity for the fabrication of a harmoniously functioning prosthesis.

When the practitioner understands the shortcomings of an articulator and its facebow system, he/she will be in a position to expect the outcome of the prosthesis and how it could be modified according to the patients' need.

Different articulators and methods have been compared for reproducibility of OP in the history, but literature provides sparse information of Hanau® Wide Vue articulator and Whip Mix® articulators being compared. These two articulators are the most widely used as semi-adjustable articulators in the field of dentistry at present time and their comparison with each other and at the same time evaluation of their transferability with a gold standard has a wide practical value.

MATERIALS AND METHODS

Twenty edentulous patients between 20 and 30 years of age¹ were selected with full complement of teeth, Angle's class I molar relation, no occlusal disharmony, no periodontal problems, or temporomandibular disorders.

All subjects included in the study were screened through a detailed case history and were well informed regarding the study design. Written consent from each subject was obtained.

Maxillary and mandibular impressions were made using polyvinyl siloxane impression material (Dentsply/Aquasil LV) with putty reline technique and two sets of casts were poured using same impressions with die stone (Kalrock®, Khalabhai Karson Pvt. Ltd., Mumbai, India).

Lateral cephalometric radiographs for the right side of the subjects were taken with a radiopaque reference marking placed on the skin at the right infra-orbital notch region² (Fig. 1). Tracings were done on a transparent acetate sheet for Frankfort horizontal plane (FH plane: by joining orbitale and porion) and OP (joining cusp tip of maxillary right canine and the mesiobuccal cusp tip of maxillary right first molar). The angle made between these two lines was tabulated.³⁻⁶ Same procedure was followed for 20 subjects and the mean angles were tabulated.

On the lateral cephalogram, the distance between the orbitale and the radiopaque marking was noted. The same distance from the radiopaque marking on the patients' skin was measured and a reference mark was drawn on



Fig. 1: Lateral cephalometric radiographs for the right side of the subjects were taken with a radiopaque reference mark placed on the skin at the right infraorbital notch region

the skin with an indelible pencil.² This reference mark confirms the position of orbitale.

Articulators were prepared before the facebow transfer as per manufacturers' guide. Facebow records for both semi-adjustable arcon articulators systems (Hanau® Wide Vue with Hanau® Spring Bow and Whip Mix® with Whip Mix® Quick mountfacebow) was carried out according to the manufacturers' guide. Orbitale (reference mark confirmed and marked by using lateral radiographs) for Hanau and nasion for Whip Mix articulators were used as third reference points. The maxillary split casts were mounted to both the articulators with fast-setting plaster.

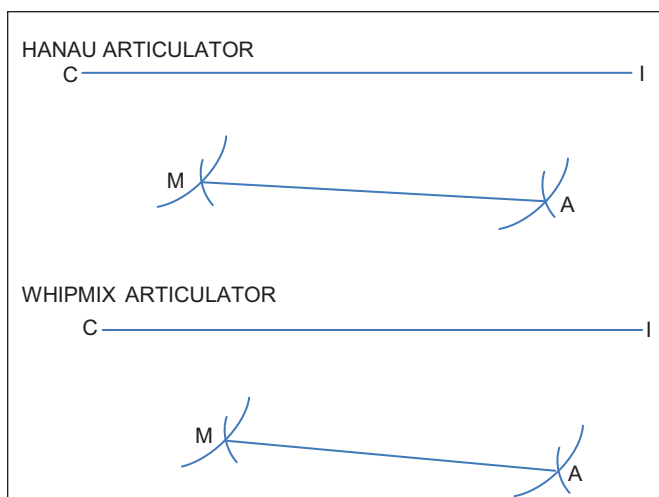
Marks were made on the mesiobuccal cusp tip of the right maxillary first molar (M) and the cusp tip of maxillary right canine (A). The OP was thus represented from a point M to point A. Two marks were established on Hanau and Whip Mix articulators: mark C was made at the center of the condylar axis and mark I on the incisal pin at the condylar axis levels. These two marks were made to maintain stationary reference points on the articulators from which marks A and M were measured with a vernier caliper having a resolution of 0.01 mm.

A Boley gauge was used to measure linear distances between several points:

- C and M
- I and M
- I and A
- C and A

Distances were drawn on a graph paper for each articulator system (Graph 1).

The angle formed by lines CI and MA was measured with a protractor to the nearest degree and was considered



Graph 1: Line joining point C and point I (represents horizontal reference plane) and line joining point A and point M (represents occlusal plane)

as the angle between OP and horizontal reference plane of the respective articulator system (Graph 1).

Same procedure was followed for 20 subjects and the values tabulated.

The values obtained were segregated into three groups:

Group 1: Angle between OP and horizontal reference plane obtained from Hanau articulator

Group 2: Angle between OP and horizontal reference plane obtained from Whip Mix articulator

Group 3: Mean angle between OP and FH plane obtained from cephalograms

Mean of 20 readings (from 20 patients) obtained from group 1; groups 2 and 3 were calculated and subjected to statistical analysis. Descriptive statistics, analysis of variance, Scheffe *post hoc* analysis for group comparison, and level of significance (P) was calculated using Statistical Package for the Social Sciences version 16 (IBM, New York, USA) software program.

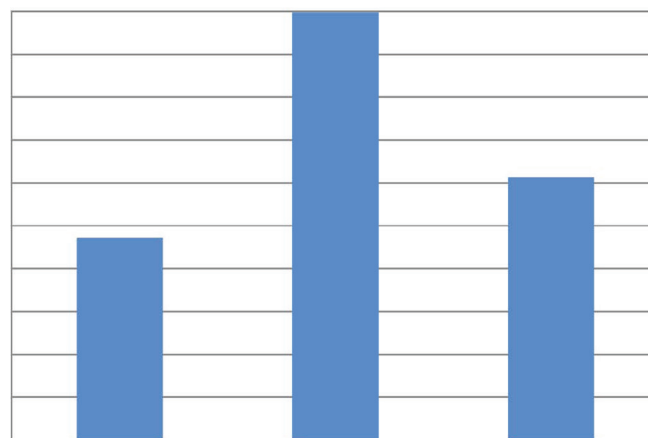
RESULTS

The mean angle between OP and horizontal plane from groups 1, 2, and 3 and their standard deviations (within groups) are represented in Table 1. Intragroup comparison of mean angle OP values showed highly significant difference (p=0.000). The mean difference between OP and horizontal plane between two articulators was found to be statistically highly significant with a mean difference of 10.51°, with group 1 values being lower than group 2 (Graph 2). Difference between groups 1 and 3 was statistically significant with a mean difference of 2.835° and group 1 values consistently lower than group 3. Difference between groups 2 and 3 readings was statistically significant, with a mean difference of 7.680° with group 2 values were on average 7.680° higher than group 3 shown in Table 2.

Table 1: Comparison of the mean values between occlusal plane and reference plane obtained from groups 1, 2, and 3

Groups	Mean	Std. deviation	p-value and significance
Group 1 (Hanau articulator)	9.4350	0.97618	0.000
Group 2 (Whip Mix articulator)	19.9500	2.03793	
Group 3 (Cephalometric evidence)	12.2700	1.58583	

p < 0.05; HS: Highly significant



Graph 2: Comparison of the mean values between occlusal plane and reference plane obtained from groups 1, 2, and 3

Table 2: Post hoc tests

		Multiple Comparisons		
		Mean difference (I-J)	Std. error	Sig.
Hanau articulator	Whip Mix articulator	10.51500*	0.50401	0.000
	Cephalometric evidence	2.83500*	0.50401	0.000
Whip Mix articulator	Cephalometric evidence	7.68000*	0.50401	0.000

*The mean difference is significant at the 0.05 level

DISCUSSION

Hanau® Wide Vue 183 and Whip Mix® Model No. 2240 articulators are the most commonly used semi-adjustable articulators for oral rehabilitation. Literature on their reproducibility and comparison between these two articulators is sparse and a study in interest of this would be valuable.

In this study, subjects were within the age group of 20 to 30 years as the craniodentofacial growth is accomplished by this age.¹

Digital lateral cephalogram was selected to obtain individual OP angle values and was considered as a standard for critical comparison of two articulators. According to Davis and Mackay,⁷ digital imaging have added benefits of high-quality images, speed of application, low radiation dosage, direct analysis, and as accurate as manual technique.

Facebow transfer was done to orient the maxillary casts in both the articulators using orbitale and nasion as third reference points (for Hanau and Whip Mix articulators respectively). According to Wilkie,⁸ in case of Whip Mix articulator, the crossbar is located 23 mm below the midpoint of the nasion positioner. When the facebow is positioned anteriorly by the nasion guide, the crossbar will be in the approximate region of orbitale. The facebow crossbar and not the nasion guide is the actual anterior reference point locator.

Gonzales and Kingery⁹ observed the lack of parallelism between the Frankfort horizontal plane and the axis-orbital plane. The 7-mm correction was suggested by the authors. However, the orbital pointer is placed 7 mm above the level of the condylar plane in the newer Hanau articulators.¹⁰ Based on this it can be concluded that both articulators use axis-orbital plane as reference for orienting the maxillary cast.

It was also shown that the position of the orbital plate of the Hanau articulator is 7 mm above the condylar axis level which helps in orienting the maxillary cast similar to the relationship between maxilla and Frankfort horizontal plane in the patient sitting in an upright position looking at the horizon¹⁰

Improper sagittal inclination of the occlusal plane will not permit the positioning of maxillary anterior teeth on the denture base, as they will appear in the patient's mouth when the patient is sitting in an upright position looking at the horizon.¹¹ Also, the relationship of posterior occlusal plane in the patient's mouth is altered preventing the masticatory forces from acting at right angles to the basal seat and further leading to loss of stability.¹²

According to an article based on facebow mounting evaluation, steep inclination of the OP will cause an increase in the setting of the protrusive condylar inclination on the articulator to become greater than that present in the patient. In this manner, the occlusion developed on the articulator may produce an error on the balancing side in the patient's mouth.¹³

According to O'Malley and Milosevic, incorrect reproduction of the steepness of the OP affects both function and esthetics. According to them, change in the vertical position of the anterior reference point of about 6 mm altered the condylar guidance angle by about 9° and resulted in further changes to cuspal inclines and heights: such an increase in steepness of the OP would increase the risk of failure. Correct replication of the angle of sagittal inclination on the articulator has consequences on maxillary movements and autorotation of mandible.¹⁴

Limitations of the study include human errors that cannot be neglected because it has been proven that

the method of recording and interpretation of the OP values from the articulator is subjected to vary between examiners. Even though the digital lateral cephalograms were taken with standard procedures, the parallax effect may lead to errors.

CONCLUSION

From the present study, it could be derived that there was a significant difference in reproduction of angle between OP and horizontal reference plane by the articulators. Transferability of articulators varied from that of the gold standard. Hanau articulator showed closer values to that of cephalometric values in comparison with Whip Mix articulator system.

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