Comparative Evaluation of Occlusal Plane Transferred on Hanau Articulator using used and Unused Hanau Spring Bow

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ABSTRACT

Introduction: Facebow allows the clinician to transfer the exact relationship of the maxilla to the skull on the articulator via the maxillary cast. It provide the effect of relating the plane of occlusion to the opening axis of the articulator as that is observed in the mouth when the reference plane is parallel to the floor. This study was undertaken with the purpose statement in evaluation of the accuracy of facebow record transfer on the articulator using Frankfort Horizontal Plane and Esthetic Reference Plane and to find out the more acceptable transfer.

Material and Methods: The study was conducted on 5 dentulous subjects. The occlusal plane was transferred on Hanau articulator using used and unused Hanau spring bows in two different planes i.e Frankfort Horizontal Plane and in Esthetic Reference Plane. Lateral cephalogram was taken for each subject in both the planes. The occlusal plane transferred with the facebows is then compared with that obtained on the lateral cephalogram.

Result: Steeper inclination of occlusal plane is obtained with Used Spring Bow. Steeper inclination of occlusal plane is obtained in Frankfort Horizontal Plane.

Conclusion: The use of Unused spring bow in Esthetic Reference Plane is recommended in order to reduce the error in the final prosthesis.

Keywords: Hanau Spring Bow,Frankfort horizontal plane,Esthetic Reference Plane.Lateral Cephalogram.

INTRODUCTION

The maxillary cast in the articulator is the baseline from which all occlusal relationships start. Facebow allows the clinician to transfer the exact relationship of the maxilla to the skull on the articulator via the maxillary cast. It provide the effect of relating the plane of occlusion to the opening axis of the articulator as that is observed in the mouth when the reference plane is parallel to the floor.

Hanau spring bow has been used since 1986. Hanau spring bow is claimed to maintain self centering property when it is positioned in patient's mouth as well as in the articulator.[1] However it has been observed that repeated use of spring bow makes it difficult to adjust the U shaped frame in the external auditory meatus on both sides because of which centering the facebow and attaching the assembly become difficult. Therefore, it can be hypothesized that occlusal plane inclination transferred to the articulator using Hanau Spring Bow which is used for a long period of time looks steeper. Steeper inclinations of occlusal plane may incorporate occlusal errors in the prosthesis. It also increases the lever action and affects the stability of the prosthesis.[1-4]

The upper member of the articulator is taken as corresponding to the reference plane of the patient which is assumed to parallel with the Horizontal reference plane. In the design of many articulators there is an assumption of parallelism between the Frankfort horizontal plane, the Axis-orbitale plane, the upper member of the articulator and the Horizontal reference plane. But studies have shown that the Frankfort horizontal plane and the Axis orbital plane are not parallel to one another.[5]

Pitchford in his study related to facebow transfer in reference to Esthetic reference plane mentioned that Frankfort horizontal plane is a misnomer and usually not parallel to the Horizontal reference when a subject is in Esthetic reference plan. Hence it maybe hypothesized that facebow records transferred on articulator in reference to Frankfort horizontal plane are steeper than Esthetic reference plane. Therefore, the facebow transfers will not be the giving same antero-posterior and vertical position of maxilla and the occlusal plane as present in the subject's mouth.[1,2]

Various studies have been done to investigate the difference in occlusal plane transfer using various facebow on various articulators but no study has been done on the occlusal plane transfer on the same articulator.

So the purpose of this study was to evaluate the accuracy of facebow record transfer on the articulator using Frankfort Horizontal Plane and Esthetic Reference Plane and to find out the more acceptable transfer.

MATERIAL AND METHODS

The study was conducted in the Department Of Prosthodontics at Sharad Pawar Dental College, Datta Meghe Institute of Medical Sciences Wardha, Maharashtra, India. Informed patient consent was obtained before the commencement of the study. The institutional ethical committee approval was taken before the commencement of the study.

The study was conducted on 5 dentulous subjects who were selected on the basis of following inclusion criteria

1. Patients above 18 years of age.
2. Bilateral Class I molar relationship
3. Complete permanent dentition with the presence or absence of third molars.
4. Absence of any extensive restorations or cuspal coverage.
5. Clinically normal arch forms
6. Absence of any pathologic or periodontal condition.
7. Normal overjet and overbite

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Exclusion criteria

1. Patients with temperomandibular or craniocervical disorders.
2. Patients with previous or current orthodontic treatment.
3. Patients with history of craniofacial trauma or surgery.
4. Patients with rotated or malpositioned teeth.

Custom made Device for measurement of occlusal plane angle

A custom made device was fabricated to measure the inclination of occlusal plane. It was an 80mm extension rod made up of 12 mm square aluminum with centric core drilled to fit over the bite fork as a sleeve with a fixing screw attached on one end. This custom made angle measuring device positioned as extension of the bite fork will indicate the steepness of the maxillary occlusal plane on the articulator. Parallelism of upper member of articulator with the horizon was checked using bubble gauges which were attached to articulator before measuring the inclination.

PROCEDURE

Measurements in relation to Frankfort Horizontal Plane (FHP) - Facebow records was made for 5 dentulous subjects using the Used Hanau spring bow and Unused Hanau spring bow in reference to Frankfort Horizontal Plane (FHP). Impression compound was used to record occlusal indentations on the dentulous bitefork. A lateral cephalogram was taken in relation to FHP for respective subjects in the Department of Oral Medicine, Diagnosis and Radiology at Sharad Pawar Dental College Sawangi (M) Wardha.

Thus total two facebow records and one lateral cephalogram was made in FHP for each subject. Facebow records were then transferred to the Hanau H2 semi adjustable articulator (Whipmix, Louisville, KY, USA) for measurement of occlusal plane inclination.

The custom made angle measuring device positioned as extension of the bite fork will give the steepness of the maxillary occlusal plane on the articulator (figure 1, 2) After recording the occlusal plane inclination on the articulator, it was compared with the occlusal plane measured on the lateral cephalogram. \

Marking the Frankfort Horizontal Plane - Frankfort Horizontal Plane was marked on the patient's face as a line extending from porion to the orbitale. The position of orbitale was located and marked with the marker pen. Porion was marked at the superior most point on tragus of the ear. Subject's Frankfort plane was made parallel to the reference horizontal and checked with line leveler. This position was kept constant at the time of facebow record and lateral cephalogram. Occlusal plane was marked on lateral cephalogram by joining the incisal edge of central incisor and the cusp tip of first molar.

The angle formed by these two planes was measured with the help of Nemoceph software.

Measurements in relation to Esthetic Reference Plane (ERP) - Facebow records will be made for 5 dentulous subjects using the Used Hanau spring bow and Unused Hanau spring bow, in reference to Esthetic Reference Plane (ERP). Impression compound was used to record occlusal indentations on the dentulous bitefork. Esthetic reference plane was obtained by asking the subject sitting erect, head level and eyes gazing at the horizon. To make the facebow in ERP two bubble gauges was attached on U shaped frame of the two facebows.

A lateral cephalogram was also taken in relation to ERP for respective subjects.

Marking the Esthetic Reference Plane on patients face for lateral cephalogram - Esthetic Reference Plane will be marked on patients face by asking the subject sitting erect, head level, and eyes gazing at the horizon. A horizontal line was drawn from porion anteriorly irrespective of its relation to orbitale. Line was checked for parallelism with reference horizontal using line leveler. Line was marked using thread dipped in radio opaque barium sulphate cement (Microbar-HD). Radio opaque line obtained was considered as horizontal reference plane for measuring occlusal plane inclination on lateral cephalogram radiograph (figure-3) Occlusal plane was measured with the help of Nemoceph software.

Comparison of Unused Hanau spring bow and Used Hanau spring bow was done with lateral cephalogram for checking most accurate facebow in both reference planes respectively. Comparison was also done to check the difference in occlusal plane inclination in Frankfort Horizontal Plane with that of Esthetic Reference Plane.

STATISTICAL ANALYSIS

The data obtained was analyzed as per SPSS 17 and P value was taken as significant only when it is less than 0.5.The statistical methods used in the analysis was Pearson's Correlation Coefficient and student unpaired t test.

DISCUSSION

Accurate positioning of the maxillary cast on the articulator is an important part in many techniques. Failure to accurately transfer the anteroposterior relationship on the articulator can result in

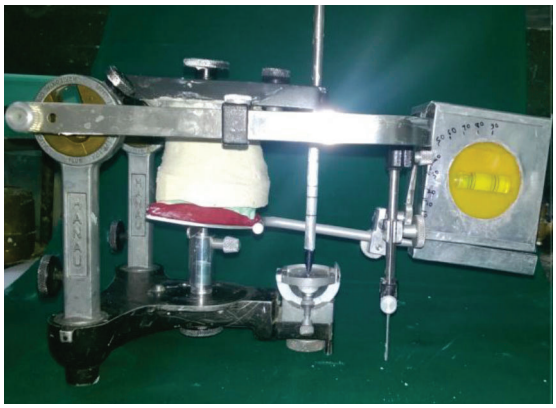

Figure-1: Facebow transfer using unused spring bow

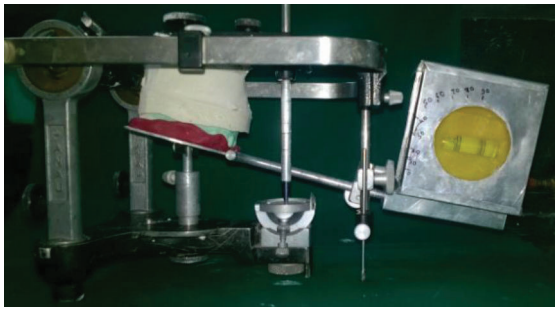

Figure-2: Facebow transfer using used spring bow

Figure-3: Radiograph showing esthetic reference plane marked with barium sulphate

error in final occlusion of a prosthesis. An improperly selected occlusion plane may cause denture instability and decreased masticatory efficiency.

Facebow was developed in conjunction with articulators to relate the maxillary arch to the axis of the condylar hinge in three planes of space. A facebow is a mechanical device which uses tripod localization of two posterior references representing each of the temperomandibular joint and an anterior reference point to relate the maxillary cast vertically to the selected horizontal reference plane.[6]

A horizontal reference plane may be established on the face with one anterior and two posterior reference points. It is from this plane the measurements of the posterior anatomic determinants of occlusion and mandibular motions are made. Various horizontal planes are Frankfort Horizontal Plane, Esthetic Reference Plane, Axis Orbitale and Campers plane.

With the above data obtained by the study mean standard deviation of 1.27 was obtained with new spring bow in Frankfort Horizontal plane whereas it is 1.80 in esthetic reference plane. Standard deviation in frankfort horizontal plane with used spring bow was 1.46 whereas in esthetic reference plane it is 2.29. On comparing these data with that obtained on the lateral cephalogram more deviation was observed in Frankfort Horizontal Plane than in the Esthetic Reference Plane.

Gold and Setchell compared the cast positions using three articulators and facebow systems and showed small variation.

O'Malley and Milosevic in their study found that a change in the vertical position of the anterior reference point by 6mm alters the condylar guidance by 9mm, thereby resulting in cuspal incline changes. Such an increase in steepness of occlusal plane would increase the risk of failure when planning orthognathic surgeries.[6]

Sagittal inclination of the occlusal plane of articulated maxillary casts to the horizontal reference plane using two different facebows (used and unused Hanau spring bow) and articulator system was evaluated in this study and was then compared with the cephalometric occlusal cant. Maxillary cast were then mounted on a semi adjustable articulator following facebow transfer. Using the custom made device the inclination of the maxillary occlusal plane with reference to Frankfort horizontal plane and Esthetic reference plane was measured. Degree of occlusal cant on lateral cephalogram was also evaluated.

Pitchford (1991)[1] by his study concluded that the error obtained in the facebow transfer is the result of the assumption of parallelism between the axis orbitale plane and the horizontal reference plane when compared to Esthetic reference position.

He in his study; he related to facebow transfer in reference to Esthetic reference plane mentioned that Frankfort horizontal plane is a misnomer and usually not parallel to the Horizontal reference when a subject is in Esthetic reference plane. Hence it can be said that facebow records transferred on articulator in reference to Frankfort horizontal plane are steeper than Esthetic reference plane. Therefore, the facebow transfers will not be giving same antero-posterior and vertical position of maxilla and the occlusal plane as present in the subject's mouth.

The results of this study are in agreement with the results of the study conducted by Nazia Nazir,M Sujesh, Ravi kumar and Sreenivas (2014)[7] did study on 80 subjects to investigate the possible differences in the antero-posterior steepness between two different facebow and semi adjustable articulator system (Hanau and Girrbach). They found that less variation was seen in the occlusal planes obtained in Hanau articulator system when compared with the one's on the lateral cephalogram as compared to the Girrbach system. The facebow uses an approximate axis-orbital plane for orienting the maxillary casts. Several studies have shown that relating the axis orbital will lower the maxillary casts anteriorly from the position that would be established if Frankfort horizontal plane was used. They concluded that the Frankfort plane to maxillary plane relationship was better

		N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Angle recorded by Hanau spring bow (new)	Frankfort Horizontal Plane	5	15.98	2.86	1.27	0.85	0.42 NS, p>0.05
	Esthetic Reference Plane	5	14.10	4.02	1.80		
Angle recorded by Hanau spring bow (used for a year or more)	Frankfort Horizontal Plane	5	19.98	3.27	1.46	0.70	0.50 NS, p>0.05
	Esthetic Reference Plane	5	18.06	5.13	2.29		
Angle recorded by lateral cephalogram (degree)	Frankfort Horizontal Plane	5	13.68	4.62	2.06	0.44	0.66 NS, p>0.05
	Esthetic Reference Plane	5	12.44	4.08	1.82		

Table-1: Comparison of Angle recorded by Hanau spring bow (new) and Angle recorded by Hanau spring bow (used for a year or more) (degree)with Angle recorded by lateral cephalogram (degree) in Frankfort Horizontal Plane and Esthetic Reference Plane (Student's unpaired t test)

transferred on a Hanau articulator as compared to the Girrbach articulator.

Thus the steepness that is obtained in the present study by using Frankfort Plane as a reference plane is partly due to the design of the Hanau articulator system.

Pitchford J.H. (1991)[1] further concluded that Facebow used with orbitale (i.e in Frankfort Horizontal plane) is unable to transfer the esthetic reference position to the articulator, but instead places the incisal edges of maxillary teeth at significantly lower level.

In his study, measurements were made of the vertical relationship of porion to the orbitale. In the Esthetic reference position, orbitale averaged 11.4mm above porion with a standard deviation of 5.24mm. Kruger discussed planes of orientation in 1986. He tested variations in natural head position by using bubble gauges on facebow and found that the natural head position was the most comfortable position of the patient when gazing at the horizon. He found that the average fluctuation of natural head position within each tested subject was smaller than that determined variation in locating Frankfort horizontal plane, only 0.18-0.34 inches in each subject (Kruger, 1986).[5] This explains the result obtained in present study. The steeper inclinations using both the facebow were obtained in Frankfort horizontal plane maybe because it is not the horizontal reference plane of an individual. Recording the facebow in esthetic reference plane, places the head in the natural head position which is parallel to the horizon reducing the errors that are incorporated using FH plane and thus giving a more accurate transfer as present in the patients skull which was obtained by the lateral cephalograms in the present study.[1]

Bubble guage was used in the present study to locate the natural head position of the subject and to make the records in Esthetic reference plane. This is in agreement with the study by Elwood Stade, Jay G.Hanson and Constance L. Baker (1982).[10] They concluded that more accurate anterior reference position located superiorly than those which are commonly used example-orbitale in Frankfort horizontal plane. They suggested that the use of an adjustable articulator base in association with a bubble gauge facebow apparatus will aid in obtaining a plane similar to horizontal reference plane by adjusting the patients head position so as to obtain better esthetics and plane of occlusion.

In the present study the reading obtained with the unused spring facebow for the same subject was less steep than the used spring facebow. This is in agreement with the study conducted by O'Malley and Milosevic (1999).[6] They conducted a study to investigate possible difference in the steepness between the semiadjustable articulators and its effect on surgical planning for mandibular osteotomies. In their study they used 3 different types of facebow; Denatus

ARL (facia facebow) Denar and Whipmix (springbow) quickmount. They took records using the 3 facebows and correlated it with the lateral cephalograms. The results showed that the whipmix was closest to the lateral cephalogram whereas Denatus flattened the occlusal plane more severly on the articulator by 6.5 degree) thereby producing errors. This is in agreement to the results obtained in the present study.

The steeper records obtained using spring bow can be due to the loss of its self centring property which was proved by a study conducted by Chandrika Veerareddy et al (2010).[9] They in their study on six spring bows (3 new and 3 used for one year) found that Hanau spring bows can maintain centricity when they are flexed up to 140 mm. Used spring bows may not maintain centricity beyond 140 mm possibly due to fatigue. This can be the cause for steeper inclinations which are obtained in the present study using Used Spring Bow.

CONCLUSION

Steeper inclinations was obtained while using Frankfort horizontal plane.

Steeper inclinations was obtained while using Used Hanau Spring Bow.

Hence the use of New Spring Bow in Esthetic reference plane is recommended for accuracy of occlusion in the final prosthesis.

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