

## ORIGINAL RESEARCH

## Clinical evaluation of three different anterior reference points on protrusive condylar guidance angle using a semi adjustable articulator and lateral cephalogram

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## ABSTRACT

**Background:** Studies had shown that different anterior reference points can mount the maxillary cast in variable position in the articulator which may affect the protrusive condylar guidance angle on setting the semi adjustable articulator. So there is a need for search of reliable anterior reference point in orienting the maxillary cast on the articulation for accurate prosthesis fabrication.

**Aim:** The aim of this study was to determine the effect of 3 different anterior reference points Orbitale, Orbitale minus 7mm, 36mm from the incisal edge of maxillary central or lateral incisor on the protrusive condylar guidance values registered on Hanau wide vue articulator and compare it to the protrusive condylar guidance angle obtained from lateral Cephalometric tracings.

**Materials and methods:** A total of 30 healthy human subjects were randomly selected for this study from volunteer dental students. Orbitale, Orbitale minus 7mm, 36mm from the maxillary incisal edge of the subjects were the three anterior reference points used for facebow transfer using Hanau springbow. With the help of protrusive records, articulation was done in Hanau wide vue articulator using this record and condylar inclination values were noted on right side and left side. Three sets of lateral cephalometric radiographs were taken in maximum intercuspation and protrusive position, traced manually and values tabulated for all 30 subjects.

**Results:** Mean value of orbitale is highest and mean value of 36mm from the maxillary incisal edge is lowest.

**Conclusion:** Orbitale can be used as a reliable anterior reference point in facebow transfer using hanau wide vue articulator.

**Keywords:** Anterior reference point, orbitale, Frankfort horizontal plane, semi adjustable articulators, facebow transfer, lateral cephalograms

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## INTRODUCTION

Articulation of upper and lower cast in a semi adjustable articulator differs from that of a hinge articulator.<sup>1</sup> A semi adjustable articulator can produce accurate mounting of dental cast and can closely simulate mandibular movements.<sup>2</sup> Mandibular condyle plays a very important role for functional range of mandibular movements within the physiological limits.<sup>3</sup> Maxilla has a definite three-dimensional relationship to all mandibular movements. Facebow transfer is the first step in recording this three-dimensional relationship of the maxillary arch to the condylar path.<sup>4</sup> Two essential steps which are necessary to orient the maxillary cast on the articulator are transverse hinge axis of the patient, and the anterior point of reference selected which forms a horizontal plan of reference where a

line is drawn through the selected anterior reference point and transverse hinge axis.<sup>5</sup>

Many researchers have suggested various horizontal reference planes for proper orientation of maxillary cast on the articulator.<sup>6</sup> In facebow transfer the anterior reference point (infraorbital notch) together with two posterior opening axis (hinge axis) reference points forms the axis orbital plane.<sup>7</sup> Most articulator system uses this as the horizontal reference plane. Certain researchers had used orbitale minus 7 mm and the superior and inferior annular notch present on the incisal guide pin of the articulator as an anterior reference point for facebow transfer, but the influence of various anterior reference points on the condylar guidance angle were not researched much. 37 mm and 54 mm from the orbital plane were the markings present in the

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incisal guide pin of hanau wide vue articulator as superior and inferior annular notches. There is a need to know which anterior reference point would orient the cast in nearest and best reproduce the condylar guidance values of a patient. As researched by most researchers' casts mounted on the articulator with orbitale usually place maxillary incisal edges too inferiorly this can cause protrusive condylar guidance angle too high, usually 40 to 50 degrees instead of the expected 30 to 40 degrees. Inaccurate or variation in setting condylar guidance angle in articulator during prosthesis fabrication will cause occlusal disharmony and interference during functional movement. This will lead to increased chair side denture adjustment time and inaccurate prosthesis.

Thus, an anterior reference point used for mounting maxillary cast in the articulator can be selected on the face of the patient for facebow transfer or present on the articulator incisal guide pin, but these various anterior reference point can mount the maxillary cast either high or low in the articulator which affects the protrusive condylar guidance angle on the articulator.<sup>8</sup> So, there is a need for search of reliable anterior reference point in orienting the maxillary cast on the articulation for accurate prosthesis fabrication.<sup>9</sup> Selection of the reliable anterior reference point needs special attention during its selection. A reliable anterior reference point will place the anterior teeth and the occlusion in the articulator as same position and form as in the patient.<sup>10</sup> The objective is usually to achieve an aesthetic appearance and good occlusion.

The purpose of the present study was to determine the effect of 3 different anterior reference points orbitale, orbitale minus 7 mm, 36 mm from the cutting edge of maxillary central or lateral incisor on the protrusive condylar guidance values registered on hanau wide vue articulator and compare to the protrusive condylar guidance angle obtained from lateral Cephalometric tracings. These three different anterior references will register the same protrusive condylar guidance angle using hanau wide vue semi adjustable articulator is the null hypothesis of the study.

## MATERIALS AND METHOD

### The ETHICAL COMMITTEE APPROVAL:

This study was done after obtaining approval from the institutional ethical committee.

### Inclusion criteria:

Class 1 molar relationship with full complement of teeth present exhibiting average degree of horizontal and vertical overlap.

No history of orthodontic treatment or extraction.

No temporomandibular disorder and bony abnormalities.

Good neuromuscular control and physical and mental health.

### Exclusion criteria:

Class II and class III molar relationship.

Temporomandibular disorders, poor neuromuscular control.

Orofacial tumours and gross facial deformities.

Parafunctional habits.



Figure 1: Right Protusive position



Figure 2: Right Maximum Intercuspation

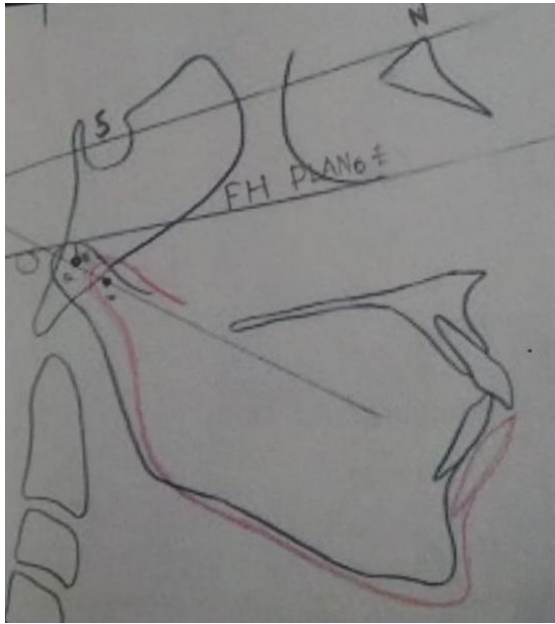


Figure 3: Right Lateral Cephalometric Tracing

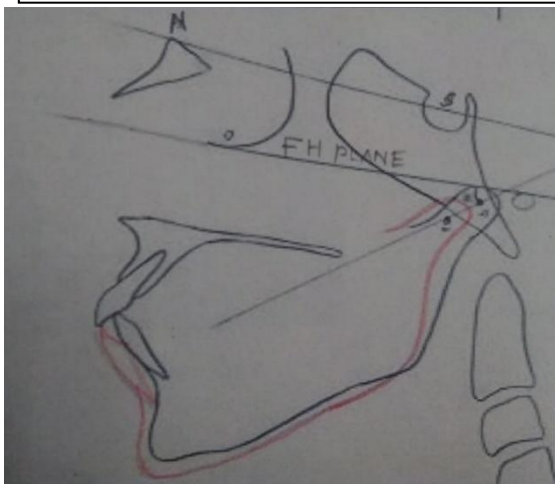


Figure 4: Left Lateral Cephalometric Tracing

#### PROCEDURE:

A total of 30 healthy human subjects were randomly selected for this study from volunteer dental students. Informed consent was taken from each patient. The following clinical procedures were performed for each individual.

Upper and lower arch impression were made using irreversible hydrocolloid impression material, disinfected, and cast were made using type III dental stone.

#### FACEBOW REGISTRATION:

Orbitale, orbitale minus 7 mm, 36 mm from maxillary incisal edge of the subjects were the three anterior reference points used for facebow transfer using hanau springbow.

Lower rim of the right orbit is palpated for infraorbital notch or orbitale as reference point was marked with indelible pencil for confirmation, a radiopaque material (gutta percha) was placed in orbitale, and lateral Cephalometric radiograph was taken. After confirmation of orbital reference, this was used for facebow transfer.



Figure 5: Left protusive condylar guidance measured



Figure 6: Right protusive condylar guidance measured

The softened impression material (DPI green stick compound) on the bite plane is seated against the maxillary occlusal surface to create a distinct imprint without metal contact. So that the facial midline was centered in the middle of the fork and the posterior areas were stabilized by the molar teeth. The stem of the biteplane must extend approximately parallel to the sagittal plane and be at the left side of the patient. The nylon earpiece of the facebow were made to enter the external auditory meatus of the patient ears. The orbital pointer should be parallel to the anterior reference point marked on the face. Loosen the two frame thumbscrews and

completely release the earpiece from the meatus. And direct the patient to open and withdraw the occlusal indexed biteplane/facebow assembly. The entire facebow assembly was removed from the patient. Another pencil mark was made 7 mm below the orbitale and forms orbitale minus 7 mm as second reference point, second facebow transfer done with this reference point. The third facebow record was made by marking 36 mm from the cutting edge of maxillary central incisor along the line parallel to intercanthal distance considering anterior reference point on the patient. Similar procedure was carried out in all thirty subjects.

#### Articulator preparation and mounting:

Three hanau wide view articulators were used to accept the three facebow record. The horizontal inclination of both condylar guidance was adjusted to 30 degree and the thumbnails tightened. Lateral inclination of both condylar posts 30 degree and the incisal guide were adjusted to 00. The earpiece facebow assembly was attached to the first articulator by equally adjusting the scales to attach the nylon earpieces securely over the auditory pins on the centric locks. The maxillary cast was then placed over the bite and mounted to the upper member of the articulator. Once the dental plaster mounting had completely set, the facebow assembly was detached from the articulator and the bite fork removed from the maxillary cast and articulation was completed by mounting mandibular cast by centric bite registration record using alu wax. All these steps were repeated for orbitale minus 7mm and 36 mm from the maxillary incisal edge as reference point for facebow transfer and articulation for all the 30 subjects selected.

#### Protrusive interocclusal record and condylar guidance angle measurement:

Two sets of protrusive interocclusal records were obtained using polyvinylsiloxane bite registration material. Subjects were asked to bite in edge to edge with 6mm protrusion as standard for all subjects. Raise the incisal pin and loose centric locks and thumbnuts of hanau wide view articulator for protrusive condylar guidance after removing the centric interocclusal record. Seat the protrusive interocclusal relation record onto the lower occlusal surface and adjust engaging the upper rim into the imprint of the protrusive relation record and condylar inclination values were noted on right and left side. The hanau wide view has a condylar guidance which is graduated at 5-degree intervals, modified protractor, graduated at 1-degree interval, was attached onto the inner side of the graduated markings on the condylar element, in alignment with the markings. These values are the protrusive condylar guidance values of an articulator. These procedures are repeated three to four times and values are noted. These values are the protrusive condylar guidance values of an articulator.<sup>11</sup>

#### Lateral Cephalometric radiograph:

Two sets of lateral Cephalometric radiograph of right and left side of subjects were taken in maximum intercuspation and protrusive positions by Broadbent cephalostat with standardize head positions with exposure of 74Kvp and 10Ma. FH plane and other anatomical tracings are done using computerized software.

Porion (P) The highest bony point on the upper margin of the external auditory meatus.

Orbitale(Or) it is the lowest bony point on the infra orbital rim.

Manual tracings of the both right and left lateral cephalometric radiographic images were made on a transparent acetate paper and marked using pencil, scale based on guidelines as given by Gilboa et al. Using right and left lateral Cephalometric radiograph on tracing paper, the centres of the condyles, maximum intercuspation and protrusive position were marked. Frankfort's horizontal plane was drawn by using porion (highest point on the margin of the bony auditory meatus) and orbitale (infraorbital margin of the orbit). The most superior point on the glenoid fossa and the most inferior point of articular eminence were identified mean curvature is obtained by joining these points. A third reference line passing through the same points was extended to intersect the FH plane. The protrusive condylar guidance angle was measured using a protractor and tabulated.

The most superior point on the glenoid fossa and most inferior point of articular eminence were identified mean curvature is obtained by joining these points. A third reference line passing through the same points was expected to intersect the FH plane. The protrusive condylar guidance angle was measured using a protractor and tabulated.

## RESULTS

	N	Min.	Maxi.	Mean	Std. error	Std. dev
Right orbitale	30	34	39	37.17	.230	3.262
Left orbitale	30	32	36	35.87	.184	4.008
Right orbitale minus 7mm	30	28	37	32.93	.339	5.856
Left orbitale minus 7mm	30	23	35	29.60	.479	4.621
Right 36mm from maxillary incisal edge	30	25	33	28.83	.384	3.102
Left 36mm from maxillary incisal edge	30	23	30	26.40	.394	2.159
Right radiograph	30	40	46	43.23	.313	2.716
Left radiograph	30	40	45	42.33	.340	3.863

Table 1: Shows mean, standard deviation of protrusive condylar guidance angle of three anterior reference points orbitale, orbitale minus 7mm, and 36mm from the maxillary incisal edge and lateral cephalometry of both right and left side.

Mean value of orbitale is highest and mean value of 36mm from the maxillary incisal edge is lowest. The difference among three clinical observations are



statistically significant. Mean value of orbitale is highest and mean value of 36 mm from the maxillary incisal edge is lowest. The difference among the three clinical observations are statistically significant.

VARIABLES	SUM OF SQUARES	DEGREE OF FREEDOM	MEAN SQUARE	F VALUE	P VALUE
CLINICAL OBSERVATIONS	1041.75	2	520.87	165.26	.000

Table 2: shows One Way Anova to compare the three clinical observations on right side. Mean value of orbitale is highest and mean value of 36mm from the maxillary incisal edge is lowest.

VARIABLES	SUM OF SQUARES	DEGREE OF FREEDOM	MEAN SQUARE	F VALUE	P VALUE
CLINICAL OBSERVATIONS	1041.75	2	520.87	165.26	.000

Table 3: Shows One Way Anova To Compare The Three Clinical Observations On Left Side

## DISCUSSION

Maxilla has a definite three-dimensional relationship to all mandibular movements.<sup>12</sup> Facebow transfer is the first step in recording this three-dimensional relationship of the maxillary arch to the condylar path.<sup>13</sup> Two essential steps which are necessary to orient the maxillary cast on the articulator are transverse hinge axis of the patient and the anterior point of reference selected which forms a horizontal plan of reference where a line is drawn through the selected anterior reference point and transverse hinge axis.<sup>14</sup>

The results of the present study showed that the anterior reference point changes the protrusive condylar guidance angles also varies and this study supports the study conducted by Prajapathi et al<sup>15</sup> that a change in anterior reference point in a facebow transfer caused a change in orientation of the occlusal plane and resulted in different protrusive condylar guidance values. The protrusive condylar guidance angles changed with different anterior reference points used in this study. The casts were found to be closer to the Cephalometric radiographic position when mounted using orbitale as anterior point of reference compared to other two anterior reference points used for facebow transfer.<sup>11</sup>

For standardization, all lateral Cephalometric radiographs were taken with the same digital cephalostat taken by same operator following manufacturer instructions to decrease image distortion and magnification problems. Protrusive condylar guidance angle measured using hanau wide view articulator were with 5-degree intervals, so modified protractor is used to obtain the accurate readings upto 1 degree interval.<sup>17</sup> Selection of right interocclusal material is an important factor to be considered as shown by various comparative studies using different interocclusal recording materials.

Most of the interocclusal recording materials were the varying degrees of reproducibility of condylar inclinations when used along with different semi adjustable articulators.<sup>18</sup> Addition poly vinylsiloxane bite registration material was used in the study for protrusive interocclusal record because it is more accurate and dimensionally stable compared with other interocclusal record material based on study of Vergos and Tripodakis et al[ who in their study compared the properties and effect of four recording materials based on recording ability, stability. And how they reproduce the vertical occlusal relationship and suggested that good properties and less discrepancy was displayed by polyvinyl siloxane and polyether.<sup>19</sup>

Based on Shillinberg et al and Rosenthal et al study, the average thickness of centric and protrusive interocclusal record must be within the range of 3-5mm. so in the present study the thickness of interocclusal material were maintained at range of 3-4mm for all subjects.

Protrusive interocclusal record was obtained using polyvinylsiloxane interocclusal record material with subjects in edge-to-edge relationships. Based on studies conducted by Craddock<sup>5</sup> suggested it was important to keep same value of protrusion as the protrusive condylar guidance angle changes with the amount of protrusion and another study conducted by Posselt et al<sup>22</sup> suggested that there was relation between amount of protrusion and protrusive condylar guidance angle measurements in articulator. So, the amount of protrusion was kept 6mm the same for all the patients for standardization in the present study.

Two protrusive interocclusal records were made to set protrusive condylar guidance angle on the hanau wide view articulator and an average value was calculated from this record used as protrusive condylar guidance angle for reliable condylar guidance angle measurement.

Isberg et al stated that a high level of connection was there between the protrusive condylar guidance path and the steepness of the articular eminence.<sup>20</sup> The slope of the articular eminence varies from patient to patient. In younger age people the articular eminence is prominent compared to old aged people. It was also observed that in the present study the protrusive condylar guidance values were consistently lesser on the left side than the right side, but no definitive reason could be specified for this difference, definitive reason could be derived with increased number of subjects and the older study suggests that the right and left articular eminence rarely have the same slants, contours and declivities. Thus based on present study, when 36 mm from the maxillary incisal edge used as anterior reference point gave a wide range of difference in protrusive condylar guidance angle with lateral Cephalometric values thus they are least accurate to mount the cast to articulator and they position the cast in different

anatomic position. So, the use of this as anterior reference point is less reliable. By these result it would be right to say that hanau wide vue articulator have 37 mm marking on incisal guide pin as anterior reference point in articulation is less reliable compared to orbitale and orbitale is more reliable anterior reference point as studied by various researcher.

The order of reliable anterior reference point for facebow transfer in hanau wide vue articulator obtained by this study can be given as follows, orbitale, orbitale minus 7 mm and 36 mm from maxillary incisal edge. The orbitale as the anterior reference point when used for facebow transfer will orient the maxillary cast closest to the anatomic position of subjects using hanau wide vue articulator.

Limitations of this study:

Smaller sample size

Manual Cephalometric tracing method was used instead of digital imaging software.

## CONCLUSION

- 1.The anterior reference point has a definitive influence on the protrusive condylar guidance angle on the semi adjustable articulator.
- 2.A change in anterior reference point cause a changed in the orientation of the occlusal plane and resulted in different protrusive condylar guidance angle.
- 3.Orbitale as anterior reference point registered the highest mean protrusive condylar guidance value of 37.17 degree and 35.87 degree on right and left side respectively and nearest to the lateral Cephalometric condylar guidance value of 43.23 degree and 42.33 degrees right and left respectively.
- 4.The protrusive condylar guidance values of anterior reference point orbitale minus 7 mmm, 36mm from the maxillary incisal edge are much different from the lateral Cephalometric radiographic value hence these as anterior reference point is less reliable for face bow transfer.
- 5.The maxillary cast mounted were significantly closer to the anatomical position when orbitale used as anterior reference point.
- 6.The protrusive condylar guidance angle is high on the right side than left side by both clinical and radiographic method for all three anterior reference point selected in this study.
- 7.Orbitale can be used as a reliable anterior reference point in facebow transfer using hanau wide vue articulator.
- 8.Compared to the previous studies, sample size was larger so the results can be reliable.

## CONFLICT OF INTEREST

There is no conflict of interest

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