

# Need for an anterior point of reference in face bow transfer: The changing viewpoint. Changing concepts regarding anterior reference point\*

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It has been accepted for the past many decades that an anatomically related anterior reference point is required during a face-bow transfer to preclude functional and esthetic errors in the finished dental restoration. Various anterior reference points have been researched in an effort to achieve greater accuracy. There is at least one documented viewpoint that reference planes are not required for a correct mounting of stone casts. This paper explores the evolution of the concept of the anterior reference point and arrives at conclusions regarding the perceived need for an anterior reference point, the rationale behind the different anterior reference points and evidence supporting the need for one.

**Key words:** Anterior reference point, face bow transfer

Most prosthodontists believe that, during a face-bow transfer, it is important to transfer to the articulator, not only the anteroposterior and lateral relationship of the maxillae to the glenoid fossae, but also the vertical relationship. Many anterior reference points have been described and advocated to achieve this end.

Ercoli *et al.*<sup>[1]</sup> presented a view that reference planes were not needed for a correct mounting of the stone casts. They stated that any changes in the inclination of the maxillary cast on the sagittal plane will have no effect as far as the inclination of the condylar path is also modified for the same angle. These divergent views, together with the many related references in the literature, prompt one to explore certain questions, namely;

- 1) What is the perceived need for an anterior reference point?
- 2) Why were so many various anterior reference points advocated by different researchers?
- 3) Is there evidence of actual clinical effect of an anatomically unrelated vertical positioning of the maxillary cast in an articulator?

The aim of this paper is to review and discuss the relevant literature on the anterior reference point, in order to arrive at the answers to these questions.

## MATERIALS AND METHODS

A literature hand search was carried out and articles pertaining to the rationale behind selecting an anterior reference point in face-bow transfers selected. These were analyzed with the stated aim in mind. The articles were from the period between 1953 and 1999.

## Review

Brandrup Wognsen<sup>[2]</sup> described an apparatus that Balkwill had demonstrated in 1866. The Balkwill apparatus could be used to measure the angle formed by the occlusal plane of the teeth and a plane passing through the lines extending from the condyles to the lower incisor teeth. The angle varied according to Balkwill's investigations between 22° and 30°. Brandrup Wognsen showed in a diagrammatic representation that an average Balkwill angle of 26 degrees corresponds to a distance of 3.5 cm between the occlusal plane and a plane at the level of the condylar element. At near the end of the 18th century, Snow attempted to capture an anterior reference point by fixing the bite fork in the upper occlusion rim so that the handle was parallel with the ala-tragus line. He then placed the bite fork horizontally when the casts were mounted in the articulator.<sup>[2]</sup>

McCullum introduced to Prosthodontics the Frankfort plane. McCollum's Frankfort plane (FP) differed from the original anthropologic reference established in profile by the orbitale and porion in that, the porion

\*Presented at 31<sup>st</sup> Indian Prosthodontic Society Congress on 27<sup>th</sup> November 2003 at Hotel Ashoka, New Delhi

was substituted by the axis. McCollum thought this axis orbital plane was horizontal when the body was erect and could be used as a reference plane during face-bow transfer.<sup>[3]</sup>

Justification for using the FP was provided by Brandrup - Wognsen<sup>[2]</sup> who stated that, when measuring the condylar path extraorally according to Gysi's method, the inclination of the condylar path is reproduced in relation to a certain plane, since the lower edge of the square piece of paper on which the registration takes place is kept parallel to the horizontal part of the face-bow. However, since there is not such a guiding plane in the case of an intraoral registration with a check-bite, the Frankfort plane would give a more accurate mounting of the cast.

Weinberg<sup>[4]</sup> discussed the effect of raising and lowering the face-bow mounting on the occlusion with the help of a mathematical model. He noted that as the plane of occlusion is elevated, the condylar readings decrease and when the occlusal plane is lowered, the condylar readings increase. His mathematical model showed a small degree of error at the balancing cusp inclines. Weinberg concluded that the error at the balancing cusp inclines was within the limits of accuracy.

Certain researchers tried to locate a more accurate position of the FP in relation to the axis-orbital plane. Foremost in these researchers were Gonzalez and Kingery,<sup>[5]</sup> who showed cephalometrically that the porion was on an average 7.1 mm above the axis. They suggested compensation of error by placing the orbital pointer 7 mm above the orbital indicator of the articulator or placing the orbital pointer 7 mm below the orbitale.

Lauciello and Appelbaum<sup>[6]</sup> studied the average orbitale - maxillary incisal edge distance in three different population. They suggested that the incisal reference notch on Hanau articulators should be calibrated 47 mm below the condylar plane. However, they concluded that using a face bow with orbital pointer adjusted 7 mm above the condylar plane of the articulator is more accurate.

Wilkie<sup>[7]</sup> described five commonly used anterior reference points. He stated that the choice and use of the anterior reference points must be well co-ordinated with all the individuals taking part in fabricating the prosthesis, in order to avoid inadvertent changes in the occlusal plane.

The esthetic reference position (ERP) was brought into the picture by Stade *et al.*<sup>[8]</sup> who indexed a true horizontal plane with the patient in the ERP, with the help of two bubble gauges attached to the face-bow and duplicated it on the articulator. Stade *et al.* suggested that the use of the anterior reference point orbitale and the axis orbital plane might result in improper cants with direct untoward effect on anterior esthetics. They suggested that the bubble gauge apparatus was a useful adjunct when the horizontal reference plane was used

to develop esthetics and the plane of occlusion. They concluded that a 16.4 mm superior correction with the orbital pointer was required to duplicate the ERP. They suggested that the effect on occlusion of inaccurately mounted casts on the articulator needed to be studied.

The position of the orbitale in the ERP was also studied by Pitchford<sup>[9]</sup> who concluded that in the ERP, the orbitale was 18.5 mm higher than the axis and 11.4 mm higher than the porion. He predicted that to duplicate the vertical position of the maxillary cast in ERP, the incisal edges of maxillary incisal teeth should be 36 mm below the condylar plane of the articulator.

Bailey and Nowlin<sup>[10]</sup> studied the occlusal plane - Frankfort plane relationships on the cephalometric radiographs with those transferred to the Hanau articulator using the orbitale and the middle groove on the incisal pin of the Hanau articulator. They concluded that the Frankfort plane - maxillary occlusal plane relationship is not transferred to the Hanau articulator with either of the anterior reference points studied and use of the middle groove on the incisal guide pin as a third point of reference positions the maxillary cast on the Hanau articulator as accurately as the orbitale does.

Krueger *et al.*<sup>[3]</sup> used a standard line level to capture the true horizontal plane relative to the natural head position (NHP) (also known as ERP). They stated that an esthetically co-ordinated plane of occlusion will benefit those patients requiring difficult prosthodontic and maxillofacial reconstruction.

Ercoli *et al.*<sup>[11]</sup> stated that because of the individual variability of the NHP, it is impossible to define the horizontal plane of the reference in a patient. They stated that the reference planes were not required for a correct mounting of the casts and the accurate mounting of the maxillary cast on the articulator can be carried out by recording and using the angular relationship of the occlusal plane to the condylar path.

## DISCUSSION

The idea of an anterior reference point was mooted on the premise that a horizontal reference plane in the patient-needed to be related to the articulator, for better esthetic and functional results. Balancing side errors as predicted by Weinberg were often quoted in research papers as justification for locating an anterior reference point in face-bow transfers. However, the balancing side errors were calculated for a situation where the same incisal guidance is maintained in the articulator, which does not occur in the clinical situation. Weinberg himself stated that the small degree of error at the balancing cusp inclines was well within the accuracy of the cast construction, centric relation record and instrument itself.

Weinberg's mathematical model described steeper or

shallower condylar inclination readings with change in the vertical positioning of the cast, leading to balancing incline errors. However, the steeper or shallower readings are with relation to the sagittal horizontal plane of the articulator and not to a corresponding plane in the patient. For example, a cast may be placed  $x$  mm below the condylar plane of the articulator and also a horizontal plane in the patient, with condylar inclination  $40^\circ$  [Figure 1]. If the cast is then repositioned either superiorly or inferiorly, there will not be a change in the angle between a line drawn from a point  $x$  mm above the cast to the axis and the condylar path, as long as the same occlusal record is used during the repositioning to obtain the new condylar inclination.

Various anterior reference points were advocated based on how accurately anatomical points of the Frankfort horizontal plane could be located in relation to the axis-orbitale plane in the patient.<sup>[5,6]</sup>

Consideration of the ERP resulted in further revisions in the accepted location of the anterior reference point.<sup>[3,8,9]</sup>

Thus the accepted position of the anterior reference point shifted many times from the 35 mm below the condylar plane as advocated by Balkwill to the much steeper position caused by the FP, to the 36 mm below the condylar plane as advocated by Pitchford, without apparent effect on the occlusion and esthetics.

The literature search failed to draw up evidence from controlled trials that there is any benefit from locating an anatomically related anterior reference point during

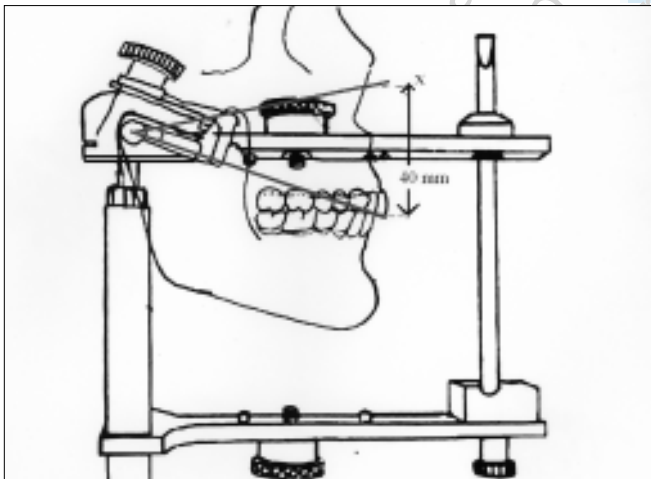
face bow transfers. The documented effects of an anatomically unrelated vertical positioning of the casts are of a hypothetical and speculative nature.

## CONCLUSIONS

- 1) The idea of an anterior reference point found acceptance on the premise that a horizontal reference plane in the patient needed to be related to the articulator for better esthetic and functional results.
- 2) Different anterior reference points were advocated based on (i) how accurately anatomical points of the FP could be related to the points of the axis-orbitale plane (ii) the position of the orbitale and porion in relation to the condylar plane in the ERP (iii) location of a true horizontal plane in the patient and its duplication in the articulator.
- 3) There is no evidence from controlled trials of any benefit from locating an anatomically related anterior reference point during face-bow transfer.

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**Figure 1a:** If casts are remounted superiorly or inferiorly, the angle between a line drawn from point  $x$  40 mm above the occlusal plane and a line along the condylar inclination will not change if the same interocclusal record is used during the new mounting.

**Source of Support:** Nil, **Conflict of Interest:** None declared.