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A Simple and Accurate Method for Mounting Models in Orthognathic Surgery

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Double-jaw orthognathic surgery cases require accurately mounted dental models on an anatomical articulator so that precise model surgery can be performed to simulate the actual surgery planned for the patient. This will allow fabrication of the intermediate and final splints necessary for accurate repositioning of the maxilla and mandible at surgery.[1]

Traditionally, a facebow device is used to register the 3-dimensional relationship of the maxillary dental arch to the Frankfort horizontal plane (FHP) using either the patient's external meati or the condylar heads (depending on the requirements of the facebow) as the posterior reference. Auxiliary components can be attached to the facebow to aid in the anterior alignment using nasion or infraorbitale. This facebow registration is transferred to the articulator to position and mount the maxillary dental model. The mandibular dental model is then mounted with an interocclusal registration.

Unfortunately, this facebow registration method often creates inaccuracies in the mounted maxillary model position, thus presenting the models in a significantly different orientation compared with the actual relationship of the patient's jaws to the cranial base structures.[2-5] The predetermined surgical movements derived from the patient evaluation and prediction tracing, when performed on malaligned dental models, may result in significant malpositioning of the jaw structures at the actual surgery, producing compromised functional and esthetic outcomes for patients.

There are reasons for inaccuracies in the traditional facebow mounting of dental models: *1*) the vertical, anteroposterior (A-P), and/or mediolateral position of the patient's external meati or condyles (depending on the reference for the facebow) may be asymmetric from side to side compared with the fixed symmetric position of the facebow mounting rods on the articulator; *2*) due to anatomical variances, the patient's FHP as determined by the facebow may be significantly different than the fixed FHP of the articulator; *3*) the facebow may be improperly positioned on the patient, or facebow components could shift when tightening the bolts, nuts, and/or screws during the registration procedure; *4*) cranial base and jaw aberrations may be present that are not reproducible on the articulator; *5*) anatomical structures may be absent (ie, hemifacial microsomia), rendering the facebow mounting totally arbitrary; and *6*) shifting of the facebow components can occur with inadequate tightening of the bolts, nuts, and/or screws at registration acquisition or with rough handling during the mounting of the maxillary model.

The purpose of this article is to describe a simple and accurate method for mounting dental models using the SAM Occlusal Plane Indicator (OPI) device (Figs 1, 2) for the SAM articulator (SAM-Prazisionstechnik, Munchen, Germany: US distributor: Great Lakes Orthodontics, LTD, Tonawanda, NY). The OPI

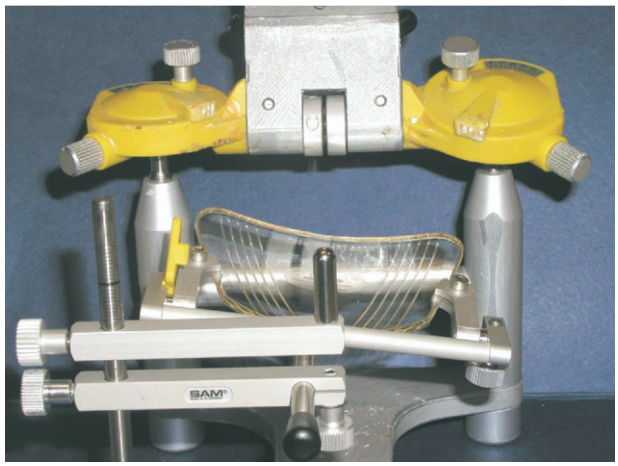

FIGURE 1. This frontal view shows the OPI device attached to the articulator. The platform can be rotated to duplicate the transverse cant in the occlusal plane as illustrated here. Symmetric lines are inscribed on the platform to facilitate aligning the maxillary dental midline appropriately with the facial midline and duplicating the maxillary yaw.

Wolford and Galiano. Simple Method to Mount Models. J Oral Maxillofac Surg 2007.

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can also be used on other articulators, including Denar (Denar Corp, Anaheim, CA), Whip-Mix (Whip Mix Corp, Louisville, KY), and, with a minor modification, Hanau (Teledyne Hanau Corp, Buffalo, NY). The OPI technique relies on the patient's clinical and cephalometric evaluations to mount the dental models on the articulator, without using a facebow. This should improve the accuracy of the mounting and dental model surgery in the treatment planning process.

Materials and Methods

The OPI device is used to reproduce the 3-dimensional coordinates of the maxillary dental arch position, including the inclination of the occlusal plane, which are important factors in treatment planning.[6-8] The information needed to correctly orient the OPI platform and position the maxillary model is obtained from the patient's clinical evaluation and the lateral cephalometric analysis.

The clinical evaluation provides the following information: *1*) presence, location, and amount of dentofacial asymmetry and imbalance, particularly involving the maxilla; *2*) amount of cant in the maxillary transverse occlusal plane; *3*) maxillary arch yaw (left to right shift of the anterior and/or posterior maxilla); and *4*) maxillary dental midline alignment relative to the facial midline. The cephalometric analysis (Fig 3) provides the following information: *1*) maxillary occlusal plane angulation to FHP; *2*) vertical position of the maxillary central incisor tips to FHP; and *3*) A-P position of the maxillary central incisors relative to a vertical plane through the mandibular condyles.

TECHNIQUE

The best accuracy in positioning the OPI and maxillary dental model includes correction for radiographic magnification of linear measurements taken from the cephalometric analysis using the following formula: AM = X − XY.

AM = adjusted measurement, X = cephalometric linear measurement.

Y = percentage of magnification (usually 8% to 10%, but may vary among machines).

With this information, the OPI platform is mounted on the articulator (Figs 1, 2), appropriately adjusted, and dental models are mounted in the following sequence.

Step 1:

The maxillary occlusal plane angulation, as determined from the cephalometric analysis (Fig 3A), is set on the OPI occlusal plane dial and lock nut secured.

Step 2:

The vertical position of the maxillary central incisor tips is calculated on the cephalometric analysis (Fig 3B) by measuring perpendicular from the FHP to the maxillary incisor tip (AM = X − XY). The OPI platform is adjusted to the correct vertical height.

Step 3:

The transverse cant of the occlusal plane is duplicated by tipping the OPI platform (Fig 1) to correlate to the vertical position of the cuspids on each side of the maxillary arch and lock nut tightened.

Step 4:

The A-P position of the maxillary central incisors is marked on the platform as determined from the cephalometric analysis (Fig 3C), measuring from a plane perpendicular to the FHP through the condyle to the incisor tips (AM = X − XY).

Step 5:

The maxillary dental model is positioned on the OPI platform with the dental midline aligned appropriately to the platform midline (facial midline),

FIGURE 2. A lateral view shows the OPI device attached to the articulator and the occlusal plane dial (*inset*). The dial is set to correspond to the occlusal plane angle on the lateral cephalometric analysis.

Wolford and Galiano. Simple Method to Mount Models. J Oral Maxillofac Surg 2007.

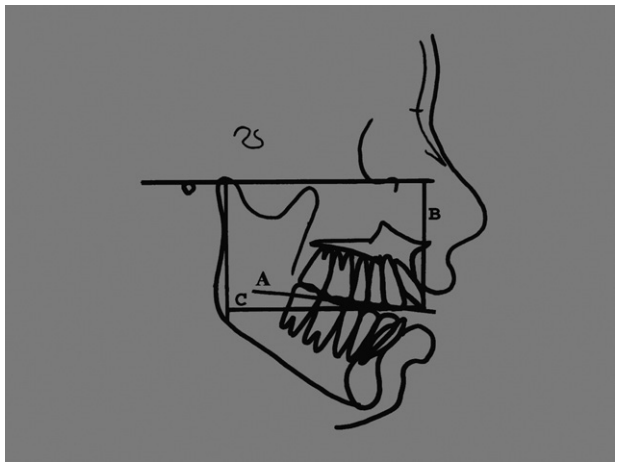

FIGURE 3. The cephalometric analysis provides important information. *A*, The maxillary occlusal plane angulation to FHP is used to set the occlusal plane angle on the OPI platform. *B*, The vertical distance from FHP to upper incisor tip establishes the vertical position of the OPI platform. *C*, Measuring from a plane perpendicular to FHP through the condyles to the incisor tips establishes the A-P position of the maxillary incisors on the OPI platform. With linear measurements, use the formula: AM = X − XY.

Wolford and Galiano. Simple Method to Mount Models. J Oral Maxillofac Surg 2007.

aligned with the proper A-P position, and the maxillary yaw is set using the inscribed lines on the OPI platform. The model is stabilized to the platform with soft wax placed on the occlusal surfaces of the first molars and incisors.

Step 6:

The maxillary model is attached to the mounting ring of the upper member of the articulator (Fig 4).

Step 7:

The mandibular model is mounted with an interocclusal bite registration taken in centric relation. The model bases are appropriately trimmed in preparation for the model surgery. We have previously described a special method to trim the model bases to further improve dental model surgery accuracy.[1]

Step 8:

Accurate model surgery, duplicating the planned surgical jaw movements for the patient, is then performed and surgical splints fabricated.

Discussion

The angulation of the occlusal plane to the FHP (normal angle = 8° ± 4°) is an important inter-relationship in both diagnosis and treatment planning for most double-jaw orthognathic surgery cases.[6-8] Ideally, the occlusal plane of the mounted maxillary model should be coincident with the cephalometric analysis. However, studies using the facebow and semiadjustable articulators have shown significant inaccuracies between the occlusal planes on the mounted models compared with the lateral cephalogram. Ellis et al[2] showed significant errors (a mean of 7°) between the occlusal planes of the mounted models compared with the cephalometric analysis when using a facebow. Palik et al[3] showed that the earpiece facebow measurement was not statistically repeatable. Bamber et al[4] compared 2 facebow transfer systems for orthognathic surgery and showed poor reproducibility. Others[5,9] have attempted to address the inaccuracies by developing more complex facebow systems.

O'Malley and Milosevic[10] compared 3 facebow semiadjustable articulator systems for planning orthognathic surgery. They concluded that all 3 articulators position the occlusal plane less steeply to the FHP compared with the lateral cephalogram. Bamber et al[11] compared 2 orthognathic model surgery techniques and found disadvantages mounting the models with the facebow, particularly in patients with steep occlusal plane angulations that required large vertical movements.

Incorrect reproduction of the occlusal plane angulation on the articulator-mounted models can adversely affect the functional and esthetic outcomes.[6-8,10] Also, inability to accurately reproduce the transverse occlusal plane cant, maxillary yaw, and asymmetries, as well as midline discrepancies, will result in incorrect mounting of the models and subsequent inaccurate model surgery. The proper use of the OPI requires the clinician to perform a comprehensive clinical evaluation and lateral cephalometric analysis. Using the OPI device, the position of the dental models should duplicate the clinical anatomical and cephalometric re-

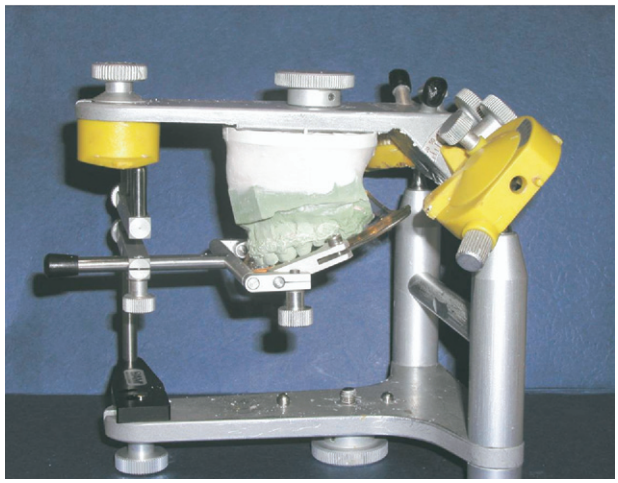

FIGURE 4. The OPI platform has been appropriately set, and the maxillary dental model is properly positioned on the platform and attached to the upper member of the articulator.

Wolford and Galiano. Simple Method to Mount Models. J Oral Maxillofac Surg 2007.

lationship with improved accuracy over the traditional facebow mounting techniques. Also, the OPI eliminates the additional chair time required by the facebow registration procedure and the associated patient discomfort. The OPI device can be used on the SAM, Denar, Whip-mix, and Hanau articulators. Based on the clinical evaluation and surgical prediction tracing, accurate dental model surgery can then be performed so that the intermediate and final splints can be fabricated. This should improve the functional and esthetic outcomes for our patients.

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