Evaluation of Facial Asymmetry with Three-Dimensional Cone-Beam Computed Tomography

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Orthognathic surgery and temporary anchorage devices can now correct malocclusions that were once considered untreatable.[1] To make a differential diagnosis between orthodontic and surgical approaches, however, the clinician needs a thorough and accurate evaluation of asymmetry.

Using conventional posteroanterior cephalograms, it can be difficult to determine whether hidden asymmetries in the posterior regions are caused by dental or skeletal factors or both. Improper head positioning in taking PA films can also lead to inaccurate analysis, since assessment of asymmetry depends on the three-dimensional head position and resultant reference lines.[2] On the other hand, while 3D cone-beam computed tomography (CBCT) can provide a wealth of information, effectively processing all the data can be a challenge.

This article presents a simple, practical strategy for evaluating facial asymmetry that involves a new method of setting a transverse reference plane in pretreatment CBCT scans. Although we use an i-CAT* scanner with Invivo5** software, other programs can be used if they have both rotation widgets for head-image reorientation and 3D volume-clipping functions.

Procedure

In the patient shown here, the maxillary dental midline coincides with the facial midline in the facial photograph (Fig. 1). The new transverse

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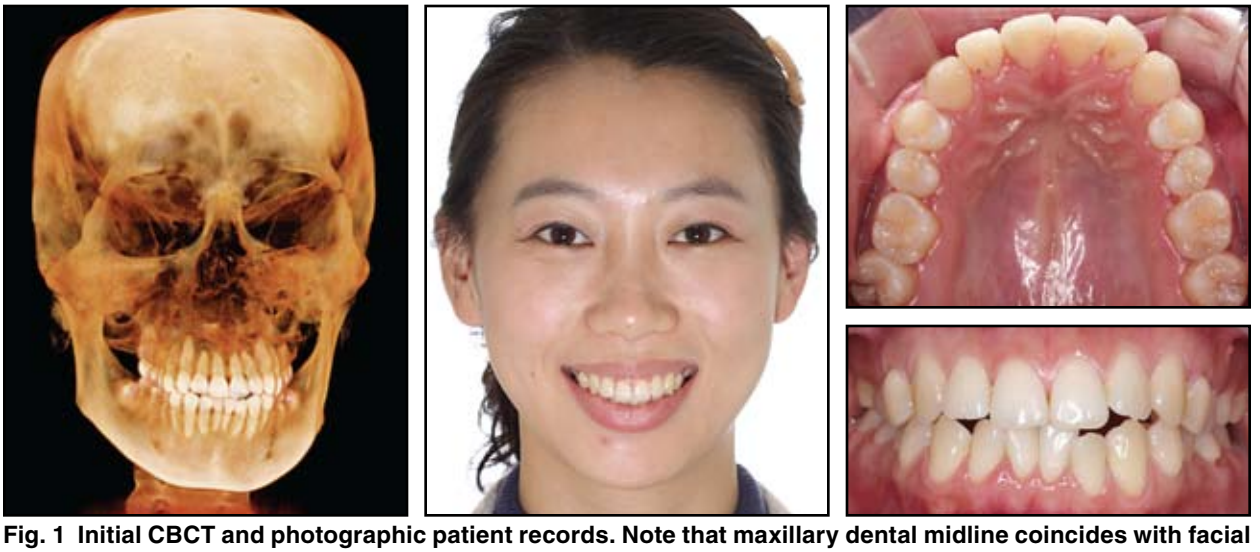

Fig. 1 Initial CBCT and photographic patient records. Note that maxillary dental midline coincides with facial midline in facial photograph.

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reference plane is determined as follows:

1. Reorient the 3D head image in the bottom view by establishing the midsagittal plane in the axial section (Fig. 2A).
2. Clip the axial section of the maxilla, which allows easier determination of the maxillary dental midline by visualizing the maxillary central incisors, and adjust the position of the maxillary dental midline relative to the facial midline (Fig. 2B,C). Verify the midline position by comparing it with the facial and intraoral photographs.
3. Reorient the head image in the frontal view (Fig. 3A). Clip the anterior portion of the face in the coronal section to aid in visualization of the lower borders of the orbital floors (Fig. 3B,C).
4. Establish a horizontal reference plane (Fig. 3B) that makes maximum contact with the lower borders of the orbital floors, and reorient the head image accordingly (Fig. 3C).
5. Make any necessary minor adjustments in the midline after consulting the clinical photographs (Fig. 4).
6. After setting the transverse reference plane, check for occlusal plane canting in the transverse dimension (Fig. 5). Clip or section the images to assess canting of each tooth as needed. The reference plane can also be used to evaluate buccal or lingual tipping of the posterior teeth and alveolar bone heights.
7. After making a differential diagnosis of the

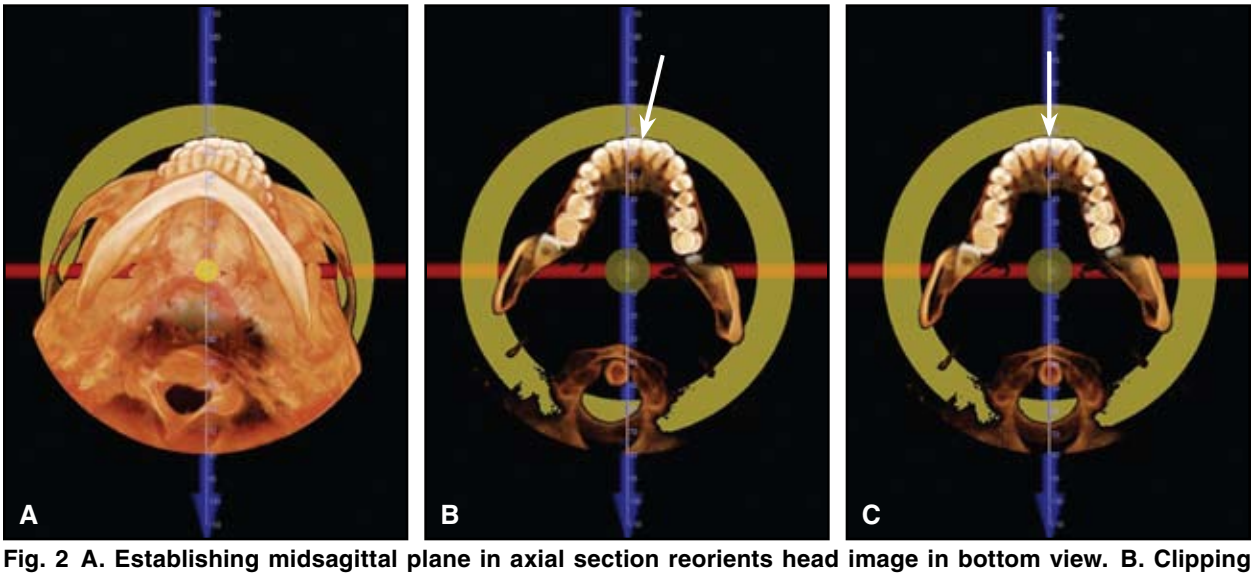

Fig. 2 A. Establishing midsagittal plane in axial section reorients head image in bottom view. B. Clipping axial section of maxilla helps operator determine maxillary dental midline (white arrow) by visualizing maxillary central incisors. C. Position of maxillary dental midline relative to facial midline is adjusted, then verified by comparing it with facial and intraoral photographs (Fig. 1).

asymmetry, plan treatment accordingly.

Discussion

Just as beauty is in the eye of the beholder, asymmetry depends on the beholder's viewpoint, closely correlating with head rotation—roll, yaw, and pitch,[3,4]—and the resultant determination of the facial midline. Although natural head position

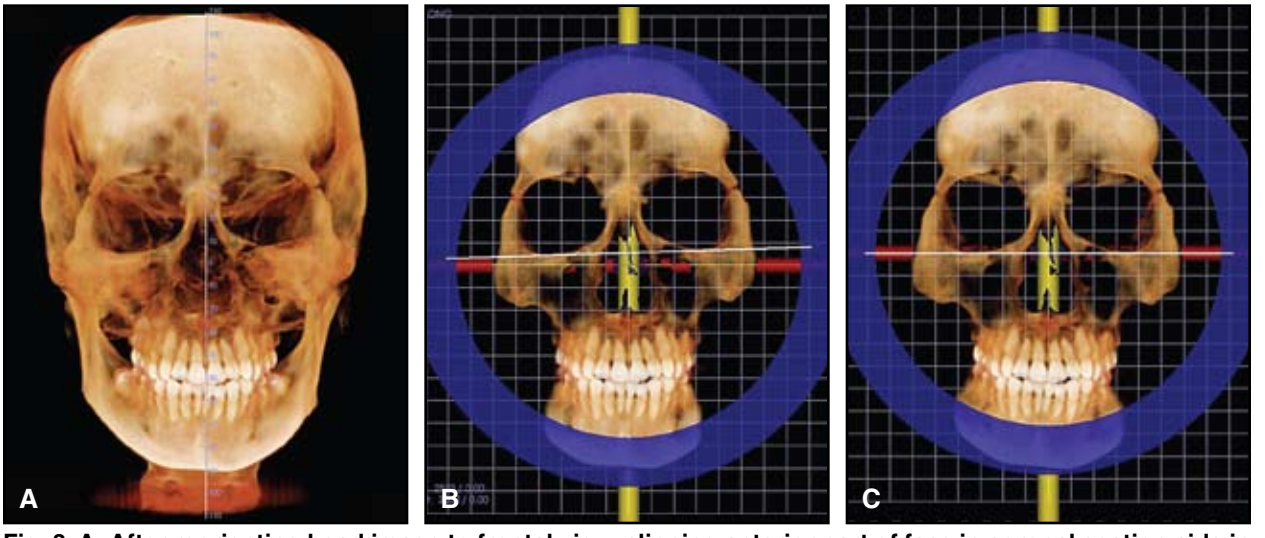

Fig. 3 A. After reorienting head image to frontal view, clipping anterior part of face in coronal section aids in visualizing lower borders of orbital floors. B. Horizontal reference plane (tangent line, in white) is established in maximum contact with lower borders of orbital floors. C. Head image reoriented according to tangent line; position of maxillary dental midline relative to facial midline is adjusted and verified by comparing it with clinical photographs (Fig. 1).

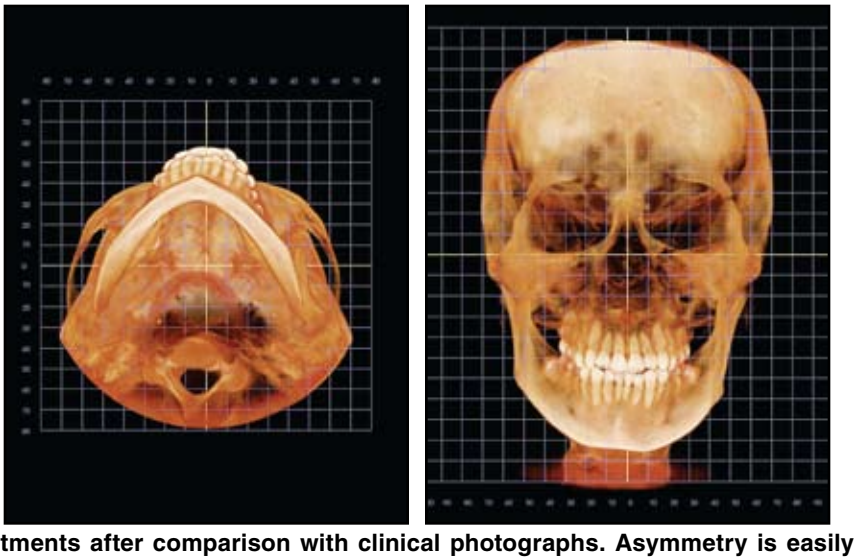

Fig. 4 Final adjustments after comparison with clinical photographs. Asymmetry is easily assessed in all dimensions.

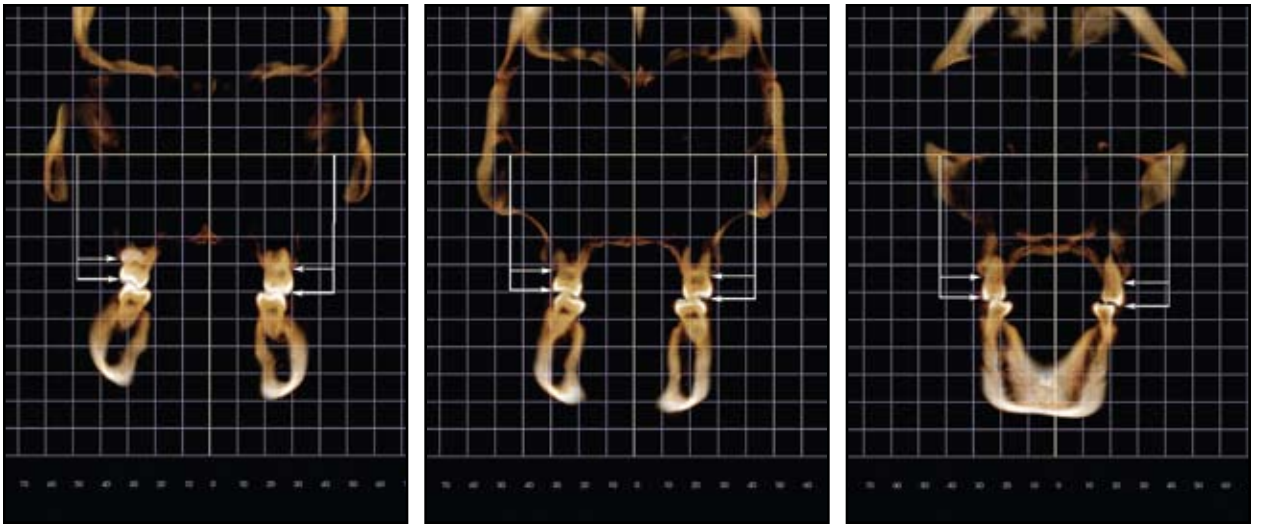

Fig. 5 After setting transverse reference plane, clinician can accurately assess occlusal plane canting in transverse dimension (grid increment = 10mm; solid white arrows indicate buccal cusps). Canting of each tooth can be evaluated by clipping or sectioning images; buccal or lingual tipping of posterior teeth and alveolar bone heights (dotted white arrows) can also be assessed.

has long been advocated for taking headfilms, an ideal position is difficult to achieve repeatedly in everyday practice. Head images must therefore be reoriented to pinpoint asymmetries that can be missed in standard PA cephalograms.

Three-dimensional imaging, while accurate enough for craniofacial analysis,[5,6] has several limitations.[7] Identifying landmarks on anatomic surfaces can be problematic, requiring suitable operational definition and computer expertise. Although some have proposed the use of projected nasofrontozygomatic and Frankfort horizontal reference planes instead of direct measurements,[8] these projected planes can also be difficult to locate. Given the laborious process of locating landmarks in 3D, the time-benefit ratio of 3D analyses is likely to be lower than that of conventional 2D analyses.

Rather than connecting two anatomic landmarks, our new reference plane uses a tangent line in maximum contact with the bilateral orbital floors. This not only reduces the time needed for landmark identification, but improves accuracy. Because asymmetry can also originate from the upper part of the face, however, it is vitally important to readjust the skeletally constructed transverse plane by referring to clinical photographs. This technique also allows easy recognition of facial asymmetries such as canting and tipping of individual teeth by clipping the images in adequate slice thicknesses (Fig. 5).

Proper evaluation of asymmetry depends on accurate establishment of the horizontal reference plane in relation to the facial midline. The method presented here is a simple and efficient tool for assessing asymmetry using 3D CBCT images.

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