Reproducibility of natural head position in normal Chinese people

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Introduction: In this study, we evaluated the reproducibility of natural head position for pitch and roll acquired using 3 methods. **Methods:** The participants were 30 Chinese adults (ages, 23-28 years) who had normal occlusion with no history of orthodontic therapy, maxillofacial trauma, or surgery. The natural head position was acquired using the self-balanced, mirror, and estimated positions, which were performed in duplicate and repeated after 1 week. Three-dimensional photographs were recorded with a horizontal laser line projected onto the face. The laser lines were observed by registering the repeated 3-dimensional photographs. The roll and pitch of the head orientation were measured with a digital ruler. Reproducibility was calculated using Dahlberg's formula and the Bland–Altman method. **Results:** The reproducibility values calculated with Dahlberg's formula were 1.51°, 1.2°, and 0.99° for pitch, and 0.78°, 0.76°, and 0.41° for roll in the self-balanced, mirror, and estimated positions, respectively. **Conclusions:** The 3 methods are reproducible for both pitch and roll, and the estimated position showed the best reproducibility among these methods. This indicates that the estimated position could be used for acquiring the reference plane in preoperative planning for orthognathic surgery. (Am J Orthod Dentofacial Orthop 2015;148:503-10)

Orthognathic surgery is a main treatment method for problems with occlusion. With the development of computer-based technologies, more medical centers are beginning to use computer-aided surgical simulations for preoperative planning. Since the reference plane plays a crucial role in the preoperative design, the choice of reference plane has received much attention, particularly the Frankfort horizontal plane (FH plane)[1] and the true horizontal plane, which is based on the natural head position (NHP).[2]

The FH plane has become the most important reference plane since it was introduced in an orthodontic study in the 1880s.[3] It is considered that the FH plane in most people is parallel to the horizontal plane when the head is in the natural position. However, research has indicated that an obvious deviation of the FH plane from the horizontal is common, with the deviations of the angle formed by the FH plane and the true vertical plane ranging from 76.3° to 120.7° (mean, 89.27°; standard deviation [SD], 5.02°).[4] This deviation must be considered if the FH plane is selected as the reference plane when planning treatment. In addition, it is difficult to locate the left and right orbitales and porions on the same plane, so it would be difficult to choose the 3 points to define the FH plane. An alternative method is to use the midpoint of the 2 points, but it is also difficult to choose these 2 points.[5]

Because of these shortcomings of the FH plane, the true horizontal plane based on the NHP is becoming more popular.[6,7] Only when the NHP is acquired can the true horizontal plane be used as the reference plane.[6,8] Two methods have been widely used to acquire the NHP: the self-balanced position and the mirror position.[9-11] It has also been reported that the head position could be reproduced with less variation when corrections are made by the doctor,[3] especially for patients with a Class II or Class III malocclusion[12]; this position is referred to as the estimated position in this article. Some authors have compared the reproducibility of the 3 methods of NHP in the sagittal plane (pitch),[3,9,11] but no studies have compared the

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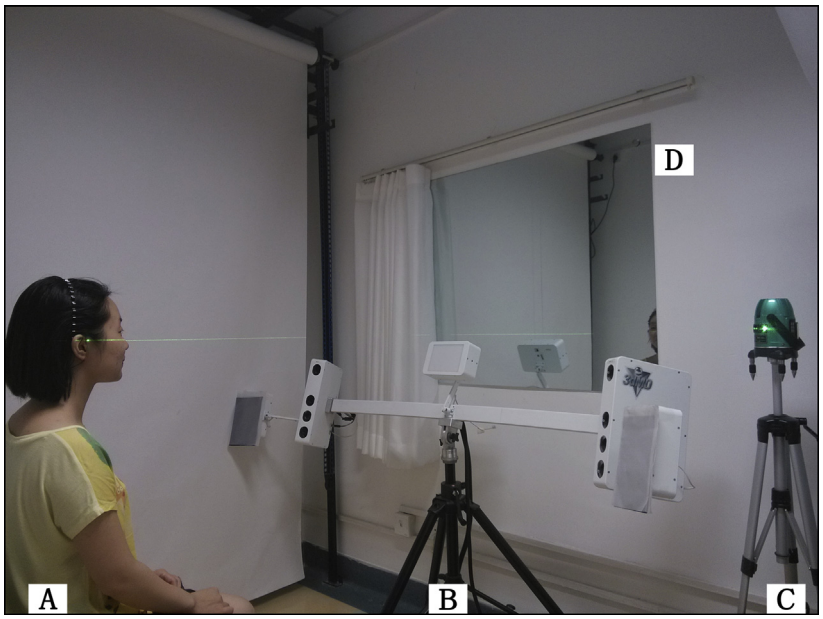

Fig 1. The setting and instruments used to record the natural head position: **A**: the subject was asked to sit upright; **B,** the 3dMDface imaging system, with the center flashlight turned off, and the right and left flashlights covered with translucent paper to reduce the intensity of the light; **C,** the laser level was set up beside the 3dMDface imaging system, and a harmless horizontal laser line was projected onto the subject's face; **D,** the mirror was mounted on the wall behind the 3dMDface imaging system (85 × 120 cm), in front of which a curtain was placed to cover the mirror during acquisition of the self-balanced position.

reproducibility of the 3 NHP methods in the coronal plane (roll).

In this study, we aimed to compare the reproducibility of NHP for pitch and roll acquired in the self-balanced, mirror, and estimated positions to identify a practical, reproducible position for preoperative digital design in orthognathic surgery.

MATERIAL AND METHODS

Thirty Chinese adults (15 women, 15 men) with normal occlusion were included in this study. Their ages ranged from 23 to 28 years (mean, 25.2 years; SD, 1.56 years). Those with a history of orthodontic therapy, maxillofacial trauma or surgery, or any disease of the motor system or vision system were excluded. If the subject had a cold with nasal obstruction at the NHP recording, it was delayed until the subject recovered.

This study was approved by the institutional review board of the Peking University School of Stomatology, Beijing, China (number PKUSSIRB-201413039). Informed consent was obtained from all participants before the study.

NHP was obtained in 3 ways: self-balanced position (position 1), mirror position (position 2), and estimated position (position 3). In the self-balanced position, each subject was first asked to sit upright with both hands on the thighs. Then, the subject tilted his or her head and decreased the amplitude until he or she was in a comfortable position, which was considered as the self-balanced position. In the mirror position, the subjects were asked to sit upright, tilt the head and decrease the amplitude, and then look at their eyes in a mirror (85 × 120 cm) located 150 cm in front of them. For acquiring the estimated position, the mirror position was adjusted by the same researcher (K.T.) for all participants. The standard criteria for the estimated position were that neither flexion nor extension of the head was observed in pitch and no obvious tilt of the head to the left or right was observed in roll.

The laser level SW902 (Saiwei, Shanghai, China) and the 3dMDface imaging system (3dMD, Atlanta, Ga) were used to record the NHP (Fig 1). According to the manufacturer's handbook, the wavelength of the laser was 635 nm, with a horizontal accuracy of 0.2 mm per 1 m. The recording procedure was as follows.