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Research Paper
Imaging

There is variability in our perception of the standard head orientation

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Abstract. The purposes of this study were to determine: (1) whether an observer's perception of the correct anatomical alignment of the head changes with time, and (2) whether different observers agree on the correct anatomical alignment. To determine whether the perception of the correct anatomical alignment changes with time (intra-observer comparison), a group of 30 observers were asked to orient, into anatomical alignment, the three-dimensional (3D) head photograph of a normal man, on two separate occasions. To determine whether different observers agree on the correct anatomical alignment (inter-observer comparison), the observed orientations were compared. The results of intra-observer comparisons showed substantial variability between the first and second anatomical alignments. Bland–Altman coefficients of repeatability for pitch, yaw, and roll, were 6.9°, 4.4°, and 2.4°, respectively. The results of inter-observer comparisons showed that the agreement for roll was good (sample variance 0.4, standard deviation (SD) 0.7°), the agreement for yaw was moderate (sample variance 2.0, SD 1.4°), and the agreement for pitch was poor (sample variance 15.5, SD 3.9°). In conclusion, the perception of correct anatomical alignment changes considerably with time. Different observers disagree on the correct anatomical alignment. Agreement among multiple observers was bad for pitch, moderate for yaw, and good for roll.

Key words: human perception; standard head orientation; intra-observer variability; inter-observer variability.

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Objects are more recognizable in some orientations than in others[1]. Faces are easier to judge when they are oriented in anatomical alignment. In this alignment, a subject is erect and his head aligned with gravity. The head is not flexed, it is not rotated, and it is not tilted[2–4].

A patient's head can be placed in anatomical alignment using two different methods: natural head posture and observer-guided alignment. In natural head posture, anatomical alignment is automatically attained by standing a patient and by asking him to look forward towards the horizon[5–8]. Alternatively, one can place the patient squarely in front of a mirror and ask him to stare at the reflection of his own

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eyes[6]. In observer-guided alignment, an observer directs the patient to rotate her head until it attains what we perceive to be anatomical alignment[9,10].

Although, most patients automatically place their heads into anatomical alignment when they stand in the natural posture, many do not. The natural head posture is particularly problematic in children and also in patients with torticollis, neuromuscular disorders, deformities of the axial skeleton, and eye muscle imbalances[11,12]. Moreover, the success of the natural posture method at aligning a head into anatomical alignment is always judged by the observer's perception of the correct anatomical alignment[13–16]. For example, a patient will be considered not to be in anatomical alignment if his intrinsic sagittal plane (plane of symmetry) is tilted, even when in natural head posture.

Thus the observer's perception of the correct anatomical alignment is the ultimate determinant of the posture he or she uses to judge faces. Yet it is unknown whether an observer's perception of the correct anatomical alignment changes with time. It is also unknown whether different observers agree on the correct anatomical alignment. The purpose of this study was to answer these questions.

Subjects and methods

This study was conducted at the University of Texas School of Dentistry at Houston. Thirty dental students (subjects) participated as test observers. Twenty were male. The observers were selected randomly, without preference for age, gender, or race. The study was exempted from the need for ethical approval by the Institutional Review Board of the University of Texas Health Science Center at Houston.

To measure how closely different viewers agree on the correct anatomical alignment, each test observer was asked to orient, into anatomical alignment, a three-dimensional (3D) color head photograph of a normal man. The orientations of all the observers were then compared. The 3D photograph used in the study was of a middle-aged man, who had a straight facial profile, facial symmetry, and normal occlusion (Fig. 1); the subject had volunteered the use of this photograph.

The 3D photograph was loaded into the software 3ds Max (Autodesk, San Rafael, CA, USA). Using this software, the image could be viewed from any direction and could be rotated. To measure the angulation of the head image, a Cartesian coordinate system was added to the 3D image at nasion. The coordinate system was deliberately not aligned with the head, so it could not be used to place the head into standard posture. The whole head was also misaligned to a random initial orientation (pitch 24.9°, roll 6.6°, and yaw 2.4°). This initial orientation was used for all tests. In order to avoid observer bias, the numbers of the initial orientation were zeroed out. In addition, the screen reference system of the software was hidden from view. Manipulation of the computer image was done by a single investigator (G.N.H.) following the verbal commands of the viewers. The observers sat directly in front of the computer monitor and were able to view the image from any angle. Several iterations of rotations were completed from different viewpoints. When the observers were satisfied with the head orientation, they were shown the final position from the front, side, top, and bottom before confirming it.

To assess whether the perception of the correct anatomical alignment changes over time, the experiment was repeated about 1 month later. The previous results were hidden from the observers during the second assessment. Finally, the orientations of the 3D photograph in anatomical alignment, in pitch, roll, and yaw, were recorded in a Microsoft Excel spreadsheet. This was done for each of the subjects twice: first alignment (T1) and second alignment (T2).

Statistical analysis

To determine whether a person's perception of the correct anatomical alignment changes over time (intra-observer comparison), a Bland–Altman analysis of repeatability was completed[17]. The intra-observer Bland–Altman agreement was considered good if it was $\leq 1°$, moderate if the agreement was between 1° and 2°, and poor if the agreement was $>2°$[11,18].

To determine how closely the different viewers agreed on the correct anatomical alignment (inter-observer comparison), the following steps were completed. First, the true anatomical alignment of the head image was determined. This was estimated by calculating the mean of all the observers' orientations. This strategy was based on the assumption that if one asks a large number of people to estimate something, the averaged answer is likely to be very close to the true[17]. Next, for each observer, his or her T1 and T2 alignments were pooled into a single orientation by calculating the mean alignment. Finally, the inter-observer agreement was evaluated by assessing the sample variance of all the mean alignments. Since the sample variance was difficult to interpret clinically, the inter-observer agreement was also evaluated using the standard

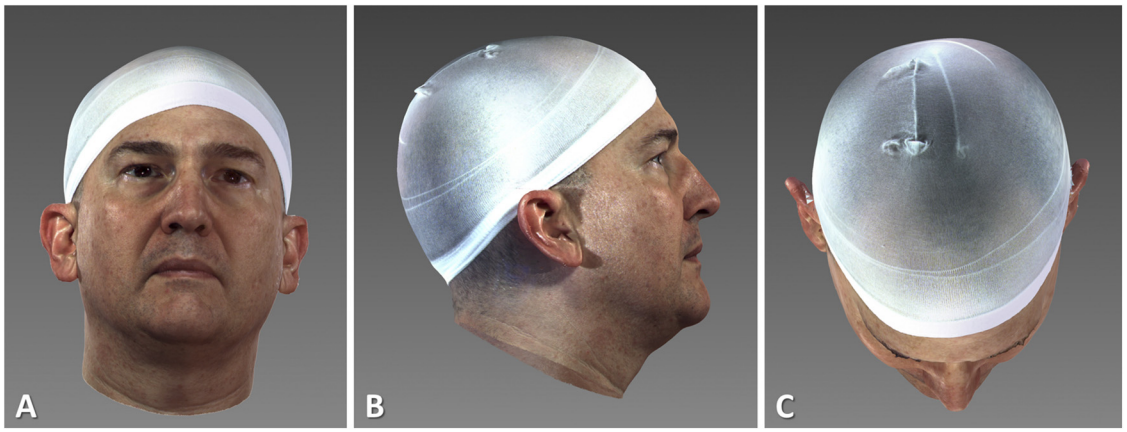

Fig. 1. The 3D color photograph used in the study. The 3D photograph was first deliberately misaligned into a random initial orientation (pitch 24.9°, yaw 2.4°, and roll 6.6°) and zeroed out. (A) Frontal view. (B) Lateral view. (C) Top view.

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