Natural head position recording on frontal skull radiographs

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This paper sets out to evaluate the variability and reproducibility of frontal head position in healthy young adults. Two posteroanterior skull radiographs of 22 dental students and 2 frontal photographs of these and 24 other students, taken at a 1-week interval, were analyzed with regard to head position and cervical spine inclination. Head position varied in the range of ±5° with regard to the vertical. The cervical spine was more often inclined to the right than to the left. The reproducibility of the head position with regard to the craniovertical angle was 1.15° and that of the craniocervical and cervicohorizontal angles 0.93° and 1.45°, respectively. Any deviation in the frontal head position tended to be spontaneously corrected on looking in a mirror. It is concluded that the frontal head position is slightly more accurately reproducible than the sagittal head position. The use of a mirror in front of the patient when recording the frontal natural head position is not to be recommended. □ *Cephalometry; methods; roentgenographic technique*

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The recording of natural head position on lateral skull radiographs has received much attention during the past few years, and different methods have been presented for clinical use (1–6). These radiographic techniques have brought new information on the relationships between form and function in craniofacial growth (7–10) and contributed to new diagnostic approaches, particularly to orthognathic surgery (11). Although there are functional abnormalities that can cause a deviation in head position in the frontal plane (12–14), very little attention has been paid to the recording of the natural head position on frontal radiographs. The aims of this study were to evaluate the variability of the frontal head position in healthy adults and to test the reproducibility of this position.

Subjects and methods

Two posteroanterior skull radiographs were taken of each of 22 dental students (19 women, 3 men), aged 21–27 years, at a 1-week interval. The radiographs were exposed at 75 kV/130 mAs with a 190-cm film–focus distance and a 15-cm distance between the film and midfrontal plane, the enlargement being 8%.

A pivot-mounted fluid-level was attached to the subject's forehead with double-sided tape, and the subject stood in a relaxed position looking into the far distance (Fig. 1). The level was then adjusted horizontally and the subject positioned in the cephalostat to face the film, with the ear rods only slightly touching the external passage of the ear. The head position in the sagittal plane was corrected in accordance with the Frankfort plane, and that in the frontal plane in accordance with the position recorded previously with the level. To facilitate visibility of the level when the subject was standing in the cephalostat, a hand mirror was attached in front of the subject. A metal chain suspended from the film holder indicated the true vertical line on the roentgen films (Fig. 2).

Head posture was calculated from each roentgenogram in terms of the craniovertical, craniocervical, and cervicohorizontal angles. The craniovertical angle was determined as the angle between the true vertical and a line drawn through the crista galli and anterior nasal spine, called the cranial central line. The craniocervical angle was deter-

Fig. 1. The level device mounted on the subject's forehead during recording of the frontal head position.

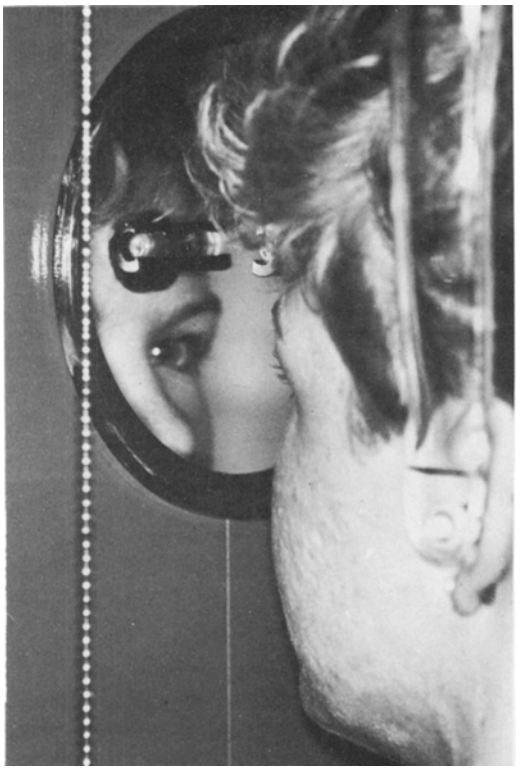

Fig. 2. Positioning the subject in the cephalostat. The position of the air bubble is checked with aid of a hand mirror.

mined as the angle between the cranial central line and a line indicating the course of the cervical spine, and the cervicohorizontal angle as the angle between the course of the cervical spine and the true horizontal (Fig. 3). If the head or the cervical spine inclined to the left, the value was indicated as negative, whereas an inclination to the right was recorded as positive. Means and standard deviations were calculated for head position and cervical spine inclination, and the reproducibility of the head posture after the 1-week interval was calculated from the formula

$$s(i) = \sqrt{\frac{\Sigma(d^1-d^2)^2}{2n}},$$

where d_1-d_2 represents the difference in either the craniovertical, craniocervical, or cervicohorizontal angle on the two radiographs, and n represents the sample size.

To study the possible effect of a mirror in front of the subject on his/her head position, the following examination was performed: two frontal photographs were taken of each of 46 dental students with a camera mounted on a tripod (Canon AE-1, Canon 100-mm/2.8 objective, Elincrom 11 and 22 flash, Agfachrome 100 RS film) and having a cord-operated shutter release. For the first photograph the subject was asked to assume a relaxed standing position (free balance position), whereas for the second, taken after a short walk, he/she looked into his/her own eyes in the mirror, the shutter being released immediately after removal of the mirror. The photographs were magnified, and the head position calculated as the angle between the transorbital line and the true horizontal line (Fig. 4). The significance of any change in head position between the two photographs was calculated with the paired t test.

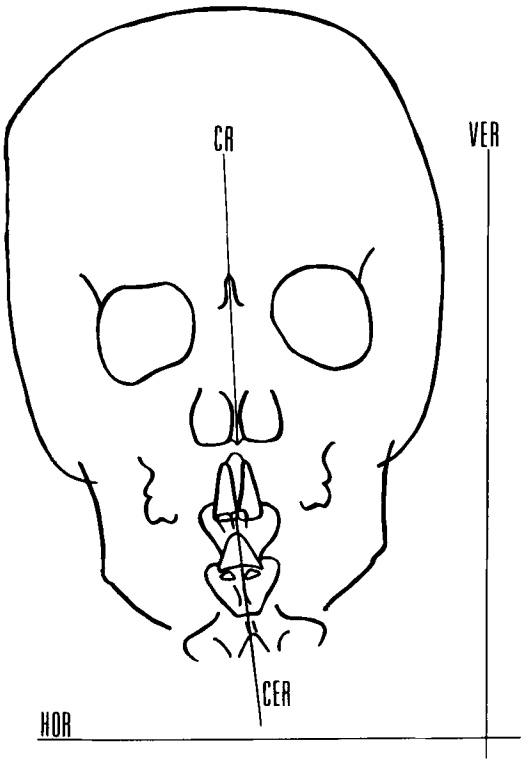

Fig. 3. Lines used for determination of head position and cervical spine inclination (CR = cranial central line; CER = main course of the cervical spine; HOR = true horizontal line; VER = true vertical line).

Fig. 4. Lines used for determination of head position change in the photographic study.

Results

The mean values and ranges for the craniovertical angle were −0.05° and −5° to +5°, respectively, and the corresponding values for the craniocervical and cervicohorizontal angles were −2.32° and −5° to +3° and +2.23° and −4° to +8°. The cervical spine was significantly more often inclined to the right than to the left, this being the case in all but three subjects. No difference in craniovertical position was observed in this respect (Table 1).

The reproducibility, s(i), of the craniovertical angle was 1.15°, and that of the craniocervical and cervicohorizontal angles 0.93° and 1.45°, respectively (Table 2).

An inclined frontal head position could be partly corrected by the use of a mirror, as the transorbital axis was more horizontal in the mirror position than in the free balance position (Table 3).

Discussion

The reproducibility of the head position in the sagittal plane in a sample corresponding to the group studied here has been found to be 1.70° (5), whereas corresponding figures of 1.43° and 1.95° have been reported for the craniocervical and cervicohorizontal variables, respectively (2). Thus the present study shows that the reproducibility of the head position is slightly better in the transverse direction. This is in accordance with the results of Lundström (15), who studied

Table 1. Means, standard deviations, and ranges (in degrees) of the craniovertical (Cr/Ver), craniocervical (Cr/Cer), and cervicohorizontal (Cr/Hor) angles

	$\bar{x}$	SD	Range
Cr/Ver	−0.05	1.91	(−5 to +5)
Cr/Cer	−2.32	1.73	(−5 to +3)
Cer/Hor	+2.23	2.45	(−4 to +8)

Table 2. Reproducibility, s(i), in degrees, of the craniovertical (Cr/Ver), craniocervical (Cr/Cer), and cervicohorizontal (Cr/Hor) angles

	Frontal plane s(i)	Sagittal plane s(i)
Cr/Ver	1.15	1.70 (Huggare, 1985)
Cr/Cer	0.93	1.43 (Solow & Tallgren, 1971)
Cer/Hor	1.45	1.95 (Solow & Tallgren, 1971)

photographically the reproducibility of head position in children and reported s(i) values of 2.0° for sagittal flexion–extension movements and 0.5° for lateral tipping of the head. The lower value for lateral tipping movements in his study may be due to the different method used for adopting the natural head posture, as he placed a mirror in front of the subject. In this study, however, the use of a mirror was shown to introduce a disturbing factor, as the subjects with a frontal tilt of the head in their free balance position tended to correct this when looking into a mirror.

Although the present subjects were presumably healthy, many of them had at least some deviation in head positions. An interesting finding was the significant predominance of right-sided inclinations of the cervical spine. A right-handed subject's spine may be expected to incline to the right and vice versa, but although there were no left-handed subjects in the group, three people did show a cervical spine inclination towards the left side. Such an inclination is evidently an expression of a normal, or at least nonpathologic, asymmetry in the human body (16). Preliminary results for 8-year-old children did not show any difference in frontal cervical spine inclination with regard to the right or left side. It is thus possible that a dominance of one side may develop in the teens.

It seems that a pronounced inclination of the spine is counteracted by a lateral tip of the head towards the opposite side, to keep the visual axis horizontal. A similar counterbalance is observed in scoliosis (12).

The determination of a landmark for a reliable cranial central line in posteroanterior radiograms is somewhat problematic owing to possible asymmetry in the cranial structures. Thus the craniovertical deviations observed here could be a reflection of maxillary asymmetry rather than of a deviant head posture. To exclude this possibility, maxillary symmetry was studied in this sample by a triangle analysis (17), the results of which did not show any significant positional difference between the right and left maxillary halves with regard to the central cranial line used here (18).

In summary, the results indicate that the frontal head position is more accurately reproducible than the sagittal head position. The cervical spine inclines more frequently to the right, a movement that is counterbalanced by a corresponding tilt of the head in the opposite direction. The use of a mirror in front of the patient may introduce an error in recording the frontal natural head position. The possible significance of deviations in frontal head and cervical position will be discussed from a morphogenetic point of view in a future article.

Table 3. Means and standard deviations of the transorbital/horizontal angle in the free balance position and the mirror position

Free balance position		Mirror position		
$\bar{x}$	SD	$\bar{x}$	SD	Difference
1.72	1.61	1.15	1.34	0.57***

*** $p \leq 0.001$ paired t test.

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