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HEAD AND NECK POSTURE AT COMPUTER WORKSTATIONS – WHAT'S NEUTRAL?

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In a study of "comfortable" head/neck posture in the absence of a visual target for 24 seated subjects, mean head tilt (Ear-Eye Line) angle was 7.7° above horizontal, and mean head/neck posture (C7-tragus against vertical) was 43.7°. Using these and other studies' findings as reference points for "neutral," studies examining posture at different computer monitor heights were reviewed: eye-level monitors resulted in head/neck extension.

INTRODUCTION

Viewing a VDT involves an interaction between two systems: vision and posture. From a visual system standpoint, lower monitor positions have been shown to be beneficial in terms of accommodation, convergence and reduced risk of Dry Eye Syndrome when compared to those at eye level (see Ankrum, 1997 for a review). The postural tradeoffs can be evaluated by several methods, including that of comparing observed postures to "neutral" postures. A valid estimate of neutral neck posture is critical to any such analysis.

Neck posture recommendations in the literature

Most studies measuring neck flexion/extension have not defined the zero starting point. For example, Chaffin (1971) has been cited as the basis for the recommendation not to exceed 30° of flexion over sustained periods. The RULA workstation assessment method (McAtamney and Corlett, 1993) considers neck flexion to be of progressively greater risk over 10° and assigns the highest risk level to any amount of extension. However, neither article defines the zero point from which flexion/extension was measured. Such a reference point would be necessary in order to apply any recommendations.

Definition of Neutral

Several attempts have been made to define neutral of the head/neck region, but most are reference points rather than postures of least musculoskeletal stress. The zero point (dividing flexion from extension) has been variously described as: the posture of the head/neck when standing erect and looking at a visual target at eye level; the posture of the head/neck when standing erect and looking at a visual target 15° below eye level; and "normal erect posture."

Physiological landmarks in measuring head/neck posture

Head tilt.

Several landmarks have been used in defining head tilt (see Figure 1). The simplest metric can be called "head tilt angle." Head tilt angle definitions have utilized angles defined by the true horizontal

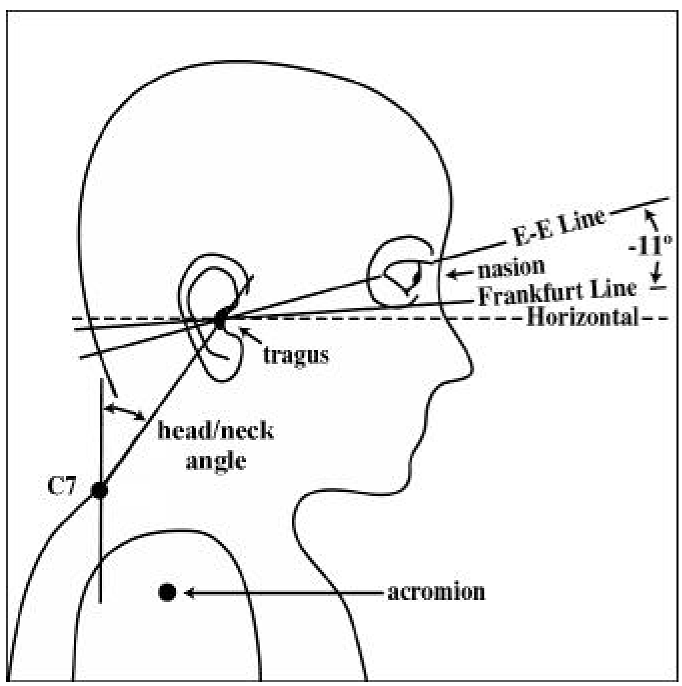

Figure 1. Head posture landmarks and metrics.

in conjunction with any of the following lines: the tragus (the cartilaginous protrusion in front of the ear hole) to the canthus (outer slit in the eyelid) (known as the Ear-Eye Line); the tragus to the bottom of the eye socket (Frankfurt Line); the tragus to the nasion (the middle of the naso-frontal suture); and the tragus to the infraorbital notch (junction of the lateral 1/3 and medial 2/3 of the inferior orbital rim). Still others have used X-rays to measure the relationships between internal structures, without reference to external landmarks.

The different metrics make it difficult to compare results. Jampel and Shi (1992) estimated that the Ear-Eye Line (E-E Line) is inclined by 10.82° from the Frankfurt Line, but no other conversion rules have been published.

Head/neck angle.

The angles described above refer to only one aspect of the complex geometry involved in head/neck posture. Eight articulations can be involved in flexion/extension – they involve the skull and C1 through T1 vertebrae. Some studies go beyond simple head tilt angle and measure a more complex posture that can be called "head/neck angle," often referred to as the degree of forward or peering head posture, or neck protraction. This is typically defined as the angle between true vertical (or sometimes horizontal) and a line connecting C7, T1, or the acromion to various skull landmarks such as those described above. The C7–tragus angle is also known as the cranio-vertebral angle.

To an extent, head tilt and head/neck angles are independent. It is possible to observe postures that combine a flexed head-neck angle with an extended head angle (picture a bifocal wearer trying to read small characters on an eye-level monitor). The muscle loads of the two postures, particularly for the dorsal muscles of the region, are almost certainly quite different, so a more useful description of head/neck posture in the sagittal plane uses both measures: head tilt angle and head/neck angle.

Ideal head-neck flexion and extension

Head tilt during "erect" posture.

Jampel and Shi (1992) found head tilt (E-E Line) to be +15° when subjects assumed a head-erect posture and stared straight ahead. Grey et al. (1966; converted from Frankfurt Line results) found a nearly identical +14.5° E-E Line when subjects sat in their posture of greatest height. Hsaio and Keyserling (1991) found a head tilt of +2° (estimated from the study description) in normal erect sitting.

Head tilt as affected by comfort or muscle equilibrium.

Grey et al. (1966) found head tilt (E-E Line) to be 0° when subjects sat in a self-defined "most comfortable" posture without a backrest.

Studies of sleeping astronauts show head angle in microgravity as 11-19° more flexed than in normal gravity (Thornton, 1978). At least part of this is believed to be due to spine straightening under those conditions, but the amount of flexion is still substantial.

Head tilt at computer workstations.

Sommerich et al. (1998) measured the E-E Line in three monitor conditions: with the center of the monitor at 0, –17.5 and –35° below horizontal eye level. They found E-E Line angles of 25, 16 and 4° respectively. Villanueva et al. (1996) found similar results: viewing angles of 0, –10, –17.5, –27.5 and –38.5° resulted in E-E Line angles of 27.3, 22.9, 15.5, 11.5 and 4.7°. Turville, et al. (1998) found E-E Line angles of 11.9 and –6.3° at viewing angles of –15° and –40°, respectively (See figure 2).

Head/neck angle during erect posture.

Raine and Twomey (1997) found a head/neck angle of 41.1° and Johnson (1988) found 40.6° with

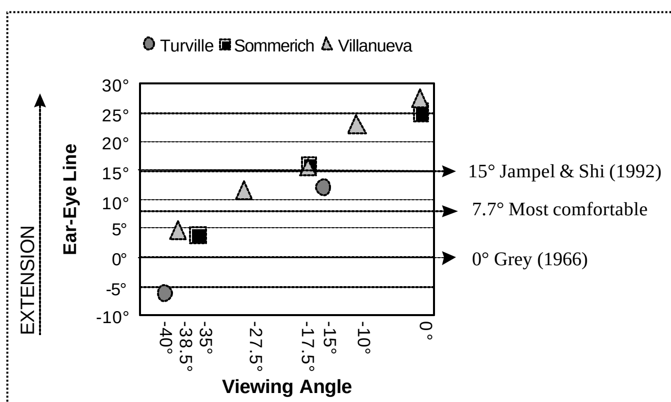

Figure 2. Head tilt at computer workstations.

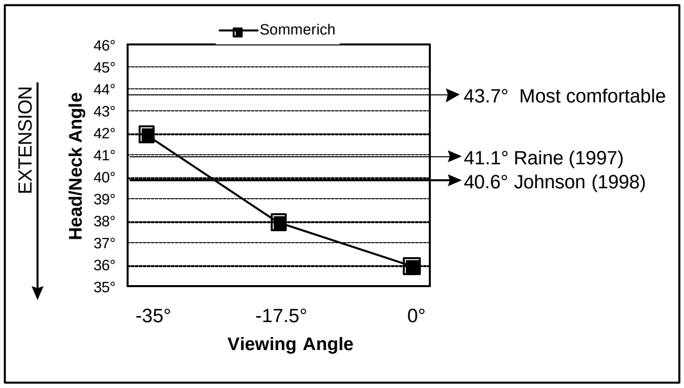

Figure 3. Head/neck angle at computer workstations**.**

standing subjects who were asked to look straight ahead. Head-neck angle was measured from the C7 to the tragus.

Head/neck angle at computer workstations.

In a study that included head/neck angle at different monitor heights, Sommerich et al. (1998) found C7-tragus angles of 36°, 38°, and 42° corresponding to center-of-monitor heights of 0°, –17.5°, and –35° below eye height, respectively (See figure 3).

CURRENT STUDY

To separate the effects of vision on posture, we measured the self-defined "most comfortable" head tilt and head/neck angles in the absence of a visual target.

METHODS

Twenty-four college students were recruited as part of a larger study on workstation configurations. Subjects were 18-28 years old and had no history of musculoskeletal disorders.

A marker was attached to C7 and the procedure was videotaped. Subjects were seated in a chair with a vertical backrest and were instructed to close their eyes and slowly move their heads, first from side to side (abduction and adduction) and then front to back (flexion and extension). They were then asked to find the position they felt was most comfortable. When the subjects announced they had established their most comfortable position, the experimenter marked the videotape. The exercise took approximately 30 seconds.

Head tilt and head/neck angles were measured using software that converted video images to data files (Image-Pro®). Head tilt was defined as the angle between the Ear-Eye Line and horizontal. Head/neck posture was defined as the angle between the vertical and a line running through C7 and the tragus.

RESULTS

The mean "most comfortable" head tilt (Ear-Eye Line) was 7.7° [SD: 8.1] above the horizontal. The mean "most comfortable" head/neck angle was 43.7° [SD: 6.9]. No significant gender differences for head tilt or head/neck angle were found.

There was a significant negative correlation between head tilt and neck angle [$r = -0.389$, $p < .05$]. Subjects with larger head/neck angles had smaller head tilt angles.

DISCUSSION AND CONCLUSION

To separate the effects of vision on posture, "comfortable" head tilt and head/neck postures in the absence of a visual target were identified by twenty-four subjects. The mean observed head tilt (Ear-Eye Line 7.7° above horizontal) and head/neck posture (43.7°, C7-tragus against the vertical) were more flexed than those reported in other studies when subjects sat at their greatest height, or stood and looked straight ahead.

Studies comparing postures under conditions of different computer monitor heights found that monitors at or slightly below eye level resulted in head tilt and head/neck postures that were in extension, compared to the "comfortable" postures reported here and in the Grey study. The degree of extension in those studies, when compared to the "comfortable" head tilt postures in this study, ranged from about 17 to about 20° of extension, and head/neck angles ranged from about 10 to 12° of extension, in the eye-level monitor condition. The monitor conditions in the range of 35-38.5° below eye level were associated with head tilt and head/neck angles consistent with the "comfortable" postures found here and in the literature. While it might appear that monitors placed at or slightly below eye level result in an erect head/neck posture, the data from this and other studies indicate that they result in neck extension.

The eye-level and slightly-below-eye-level monitor locations resulted in extension even when compared to the head-erect postures reported in the literature. One possible explanation for this apparent discrepancy is that the erect head tilt and head/neck postures reported in the literature were established with subjects looking at more distant targets than would occur at a computer monitor. The preferred line of sight becomes lower as the viewing distance decreases (Hill & Kroemer, 1986). Therefore, with a close, high visual target such as an eye-level monitor, subjects may be extending their heads and necks in order to achieve their preferred, more downward gaze angle, relative to the head.

These comparisons suffer from the limitations of the studies. Small numbers of subjects, their youthfulness, and the short observation periods make the results less meaningful than they could be in a more elaborate study. Furthermore, a number of other studies exist that could not be compared to the results cited here, because they used unclear or un-convertible measures (i.e., they did not use the E-E Line, the C7-tragus angle, and/or report viewing angle to the center of the screen).

It is hoped that this paper stimulates more uniform techniques in future studies involving this complex region of the human musculoskeletal system, and further discussion of the concept "neutral posture" as it applies to the head and neck.

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