Ergonomics in Design

Improving Field Observation of Spinal Posture in Sitting

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FEATURE AT A GLANCE: Observing seated posture is important to ergonomic assessment—proper chair fit and chair adjustment should be considered for the entire context of work demands. Recommending only one seated posture presumes that all seated work has similar location of visual targets, shoulder reach distances and support surfaces. The nature of work tasks may influence posture more than chair adjustment, and field observation of sitting should be specific for lumbar spine posture with work that may cause forward movement of the torso. The author suggests that the position and movement of the pelvis in relation to the torso is a reasonable and important indicator of spinal posture.

KEYWORDS: forward and reclined postures, slumped seating, neutral spine posture, pelvis rotation, ergonomic seating

Rationale for Reclined Sitting

The most influential studies on sitting postures to date (Andersson, Ortengren, Nachemson, & Elfstrom, 1974; Nachemson & Morris, 1964; Nachemson, 1975) show that different seated positions change joint pressures in the low back, with high disc pressure considered a primary risk factor for low back pain. Nachemson took pressure measurements in the midlumbar disc and showed that leaning the torso back past vertical against the chair reduced the disc pressure 70% compared to upright standing. Slumped sitting (forward bending at the low back without support (Figure 1), increased the disc pressure 40% compared to standing. The difference in these data suggest that reclined and neutral spine postures are better for sitting, and that forward sitting may be related to back pain syndromes.

The preferred seating angles proposed by ANSI/HFES 100 (2007) suggest either fixed or adjustable seat pan angles from 0 degrees (horizontal) to four degrees rearward. More recently proposed seat pan backrest angles are at least 90 degrees, and if adjustable, the backrest angle should recline at least 25-30 degrees from vertical (Dainoff, Maynard, Robertson & Anderson, 2012). Presuming there is a reasonable chair fit, relaxing fully onto the chair back will support the spine in a midline position, or neutral posture between forward and backward bending. The second goal is to

recline to minimize effort and vertical load, and thus be more comfortable than upright or unsupported postures. It seems reasonable to combine both goals to maximize comfort and further minimize risk factors. Some ergonomic chair designs fully accept the combined model, and support only reclined postures.

Spine posture can be affected by a host of variables: chair height and pan angle, work surface height, the position of arm and keyboard support, and the location of the visual targets and reach distances. Work variables, including the nature and pace of the work, determine how use of the neck and arms draw the torso forward. Ultimately, how we work may influence posture more than chair adjustment. Good spine posture for work in one chair position may cause high-risk spine postures for different work in the same chair. Working posture may be quite different from the resting posture used to adjust the chair.

Forward Work Tasks

Some work can be changed to allow reclined postures, but many jobs cannot: collaborative work on a desk, frequent visual cues to the work surface or the keyboard, and frequent or sustained forward reaching tasks are all done more effectively with a forward torso. Mandal (1976) described forward slumping of the spine when standard chairs with a five degree backward tilt of the seat pan were used for forward work and school tasks. Different body positions are described and expected for the different contexts of forward and reclined seated work (Festervol, 1994). Subjects report clear preferences for forward or reclined seatpan and back angles, based on the nature of the keyboard use or the work requirements (Dainoff, 1994; Shiraiashi & Ueno, 1994). A high interest level for the screen image is another factor to draw the head and torso forward (Mota & Picard, 2010).

Studies show that the muscles supporting the torso in sitting will relax when put into forward bending for more than five seconds (O'Sullivan, Dankaerts, Burnett, Booth, et al., 2006), and then stretch even farther into forward bending when the body slumps for even a few minutes (Callaghan & Dunk, 2002; O'Sullivan, Dankaerts, Burnett, Farrell, et al., 2006). The lumbar spine position is important, not just for the low back, but because slumped lumbar posture ultimately effects forward bending in the upper spine (Falla, O'Leary, Fagan, & Jull, 2007), and will encourage forward head postures (Burnett, O'Sullivan, Caneiro, et al., 2009; Caneiro, O'Sullivan, Burnett, et al., 2009). Cumulative trauma disorders in the arm and hand associated with computer work have been shown to have a strong clinical contribution from the neck (Herd & Meserve, 2008; Vicenzino, Cleland, & Bisset, 2007; Anderson & Tichenor, 1994; Waugh, Jaglal, Davis, Tomlinson, & Verrier, 2004).

Alternatively, the body may also move into a "perched" posture, sitting on the front edge of the chair, to bring the torso forward with a neutral spine, in spite of the chair adjustment. In either

case of slump or perch, the chair does not support the body well to do the work: either the body works harder to maintain a neutral spine upright without back or full thigh support (in "perched," or declined sitting), or more commonly, the torso is completely relaxed and collapsed fully forward into slumped sitting.

When the spine is in a neutral position (Figure 2), the muscles that support the spine are more relaxed (O'Sullivan, Grahamslaw, et al., 2002), they are in a position of greater strength (Adams & Dolan, 2005), there is relatively lower disc pressures (Callaghan & McGill, 2001), and the spinal joints are positioned for better movement (Burnett, O'Sullivan, Ankarberg, et al., 2008; Pynt, Higgs, & Mackey, 2001). Clinical practice also uses neutral positions of the lumbar spine for strengthening and therapeutic exercise (Farrell, Koury, & DryeTaylor, 2000).

A point of reference is needed to clearly see spinal postures in the field. Drawing attention to the angle of the pelvis as a point of reference, helps to show when work demands degrade spinal posture. The reference also helps with directing movement out of slumped positions toward more neutral postures. Rotation of the pelvis relative to the torso very closely relates to forward/backward bending at the lumbar spine (Dunk, Kedgley, Jenkyn, & Callaghan, 2009). The position of the pelvis is also considered important to maintain the muscular control of spine posture in sitting (Kasahara, Miyamoto, Takahashi, Yamanaka, & Takeda, 2008), and significantly affects the key postural muscles of the neck (Falla, O'Leary, Fagan, & Jull, 2007).

More Than Just Posture.

The current research in seating may not fully reflect the needs of those doing work in the field, for several reasons. The wide variation in body size and dimension presents particular problems for furniture fit and design, which may not be anticipated by the research strategy. People who are stiff or in pain may sit differently than others, and unusual postures may be the result of problems inside the body. Despite the fact that many studies show that better postures may reduce back or neck pain symptoms, the practical applications of those ideas in the work environment may be difficult. There are many reasons for back pain — poor seated posture may not be the only cause of pain, and better posture may not be the solution.

The perfect agreement of work surface and chair height dimensions critical for good spinal support may not be always possible in the field, but the first observation should be how the work changes spinal postures in the chair. Review of the chair and workstation adjustment should make neutral spine postures easier. Detailed directions for complete workstation and seating dimensions that preserve neutral spine posture for all work are beyond the scope of this paper, but there is a

simple guide: first determine the fundamental seating posture(s) needed, and then position the visual targets, reach distances and appropriate support surfaces to respect that goal.

Figure 1. Slumped Seating Forward.

Backward rotation of the pelvis relative to the torso indicates there is more forward bending in the lumbar spine. The angle from vertical (red) line of the pelvis reference, to the ear (yellow section) is approximately 30 degrees, implicating nearly full forward bend at the low back. Note the use of a slant board to further improve the position of the visual target and minimize forward bending.

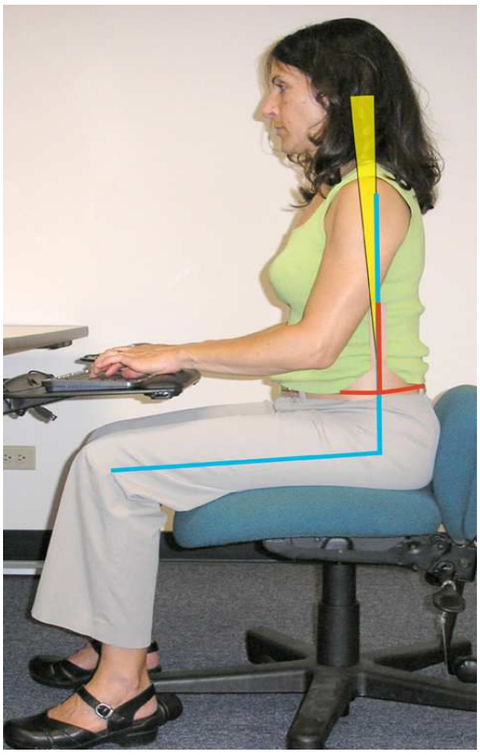

Figure 2. Neutral Spinal Posture with Level Vision.

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