Supporting the Lumbar and Thoracic Regions of the Back During Sitting

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Introduction

As sedentary, static work postures have become increasingly prevalent in our workplaces, musculoskeletal problems – in particular, low back pain and discomfort – have also increased. Recent scientific evidence has shown that prolonged, static sitting may compromise spinal structures by reducing disc nutrition, restricting capillary blood flow, and increasing muscle fatigue. Holm and Nachemson (1983), suggest that the flow of nutrient-rich fluids to and from the intervertebral discs increases with lumbar movement. Adams (1983) also found that postural changes reduced muscle fatigue. Most researchers agree on the desirability of changing one's posture while providing ade-quate backrest support. The backrest function is to stabilize the torso's posture, support spinal curvature and reduce the vertical loading of the upper trunk to the backrest thereby reducing the loading on the spine. Supporting the back in a reclined position can result in reducing the load transferred through the spine and pelvis by as much as 31 percent. This transfer of load to the backrest can significantly reduce intradiscal pressure and back muscle activity contributing to overall seating comfort. However as Chaffin and Andersson (1984) reported, adequate back support should also allow for movement and postural changes. In summary proper back support should allow a worker to maintain a relaxed, but supported, posture and should allow for freedom of active motion over the course of the day.

Review and Theory

To understand how the back changes it's posture while in a seated position, the authors previously studied (Faiks F, Reinecke S, 1998) the kinematic motion of the back during unrestricted movement. It was found that motion of the trunk represents a combination of spinal movement and pelvic rotation. As a seated individual moves from an upright to a reclined position, both thoracic kyphosis and lumbar lordosis increases. The path and rate of motion of the lumbar spine (L3) are independent of the path and rate of motion of the thoracic spine (T6), additionally, both parameters vary with the complex, combined motion of pelvic rotation, as well as changes in spinal curvature. To provide maximal support, a chair's backrest should follow the motion of the back while the seated individual changes position. The backrest must, therefore, be flexible enough to provide continuous support while moving from an upright to reclined position.

This two-part investigation was designed to understand the magnitude of independent support of the upper (thoracic) and lower (lumbar) back. It was hypothesized that the force magnitude of the thoracic and lumbar region would be unique, yet inter-dependent.

Procedures

STATIC SUPPORT: A prototype chair that consisted of two independent back elements was used to provide independent support to the lower and upper back.

Twenty-one (21) subjects (10 females, 11 males) were selected to represent the 5th, 50th and 95th percentile in physical stature. Subjects were instructed to sit in a fully reclined (110*f*), relaxed position. During this relaxed position, only the thoracic region was supported; no lumbar support was present. A researcher (from behind the chair) applied a measurable perpendicular force to the thoracic support and pushed the subject to the upright (90*f*) position. As the subject was lifted to an upright position the amount of force was recorded at 5f intervals. Lumbar support forces were recorded while the thoracic support was locked at both 90*f* and 110*f*. A force was applied to the lumbar support until the subject felt comfortable. This sequence was repeated three times for each subject. This static evaluation provided baseline force levels to study dynamic motion.

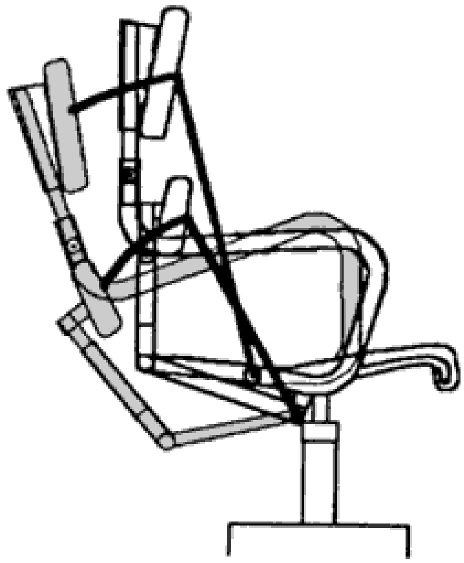

Figure 1

Test chair with independent thoracic and lumbar supports.

DYNAMIC SUPPORT: Twelve subjects (6 females, 6 males) were tested in a second test fixture. The thoracic support consisted of a support arm, which was adjustable for center of rotation and moment arm length. The thoracic support was positioned at T6 for each subject. The amount of thoracic force was produced by an external servomotor which "lifted" the subject from a reclined, to an upright position. The lumbar support was provided by a 20 cm. contoured foam surface. The amount of lumbar force consisted of a range as determined by the static study and provided dynamic movement. The subject, while continuously moving, adjusted the magnitude of lumbar support to meet their individual requirements. The selected lumbar force was recorded for each subject. Once the lumbar support level was set, subjects were asked to recline and relax. The thoracic support was then activated to "lift" the subject to the upright posture while continuously recording forces and degree of inclination of the thoracic region. Two additional tests were recorded, one with the lumbar support force increased by 1.7 kg above the subject's subjective comfort level, and one with the force decreased by 1.7 kg below the subject's comfort level. These recorded levels for both the thoracic and lumbar regions are the forces needed to dynamically support the back from a reclined to upright posture.

Results

STATIC SUPPORT: At the upright posture, the magnitude of support at the lumbar and thoracic were similar, average thoracic force was 6.22 kg (STD 2.36 kg), average lumbar force was 7.037 kg (STD 4.13 kg). The amount of force in the reclined posture was much higher for the thoracic 11.08 kg (STD 2.86 kg) as compared to the lumbar 8.22 kg (STD 2.04 kg). The rate of force change for the thoracic was 0.252 (an increase of .252 kg of force for every degree of back inclination). While the lumbar only increased at 0.058.

DYNAMIC SUPPORT: Force applied at the lumbar region was inversely proportional to the force at the thoracic region. As the amount of lumbar support is increased, the amount of support needed in the thoracic region decreased. As the amount of lumbar support is decreased, the amount of support in the thoracic region increased. A difference was observed for males and females. Male support levels for thoracic and lumbar were near equal at the upright posture. As the subject reclined the thoracic force increased. Lumbar force levels were maintained as determined from the static test. Female's thoracic support levels were lower than lumbar supports at the upright posture. As the subject reclined, the thoracic force increased but remained below the lumbar support level.

Discussion

The amount of back support required at the lumbar region differs from the thoracic region. The amount of support to the thoracic region increases at a greater rate as a person reclines relative to the support of the lumbar region. The amount of support to the lumbar region inversely affects the amount of support to the thoracic region. Supporting natural human motion requires the proper magnitude, distribution and dynamic response of the support system. This is central to ensuring that the natural motion of the spine is encouraged while being supported at all times. These differential force levels must be accommodated to ensure that the backrest continues to support posture while promoting the natural motion of the spine. The backrest should incorporate upper and lower support mechanisms that are independently adjustable. Magnitude and rate of change for the thoracic and lumbar regions vary and work in unison as a distributed support system.

References:

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