BIOMECHANICAL ANALYSIS OF OCCUPATIONAL HIGH EXERTION TASKS

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Often extremely high levels of exertion are required in manual tasks in industry, and the preponder-ance of epidemiological evidence indicates that these tasks cause and precipitate excessive numbers of low back and other musculoskeletal pain and suffering for thousands of workers, along with high medical and compensation costs. This paper will explore the historic role that biomechanics has played in under-standing these outcomes, as well as reviewing the basis for ergonomic prevention strategies used today.

The focus of the presentation will be on occupational low back pain. The discussion begins with the fundamental biomechanical reality; that the lumbar spine is often subjected to extremely large compres-sion forces when one stoops to pick up an object, even if the object is of moderate weight. Biomechanics research has disclosed that such compression forces will cause premature vertebral disc fractures in many people. This information has provided a primary basis for the “Lifting Guideline” first proposed by NIOSH in 1981, which recommends the amount of load that can be lifted in various postures by most people. The paper will discuss this outcome of the research, as well as biomechanics research in the late 80s that lead to inclusion in 1994 of a torso twisting risk factor in the “Lifting Guideline.” Much of the biomechanics research to be reviewed in this later regard focused on the role of torso muscle antagonism during lateral bending and twisting exertions.

During the 90s measurement methods and biomechanical models became available to begin to under-stand the affects on the lumbar spine of complex motions. The need for this knowledge was predicated on a growing awareness that the recommendations to keep heavy loads off the floor and close to the body when being lifted was not sufficient to prevent all occupational low back pain incidents. The growing use of mechanical aids (hoists, articulated arms and conveyors) has done a great deal to alleviate high levels of low back stress while lifting, but too often these same devices require people to twist and push and pull objects. High torso muscle antagonistic actions and vertebral shear forces were being predicted in such activities, especially when fast motions were involved. Concern also over shoulder injuries was growing related to the use of these devices, leading to the need to develop and use models of whole body exertions in industry to understand the full complexity of the problems for various groups of people.

Recently some biomechanics research began to focus on another aspect of vertebral column function that makes it vulnerable to injury, particularly during fast motions with light loads. This vulnerability is due to the column’s reliance on well coordinated torso muscle contractions to control its inherent dynamic instability. Such instability could explain why low back pain is often associated with performance of tasks when: 1) an occasional and possibly poorly planned motion takes place, 2) a sudden or unexpected motion (such as a foot slipping) takes place, or 3) when torso muscle fatigue is present.

This presentation reviews these matters and proposes that future prevention strategies will have to be much more sophisticated than is presently the case. It will propose the need for better biomechanical risk models, and will propose work cell design strategies that take advantage of newer digital human modeling CAD technologies.