UNIVERSITÄT ZU LÜBECK

TECHNISCHE HOCHSCHULE LÜBECK

Master thesis

Topic:
Assessment of musculoskeletal stress relief of the lumbar region by exoskeletal support

Summary:
Musculoskeletal disorders (MSD) are often associated with work-related constrained postures or frequent load change. Thus, they present to be the second highest cause for sick leaves in Germany and can lead to chronical pain, especially of the lumbar sacral region. In addition to ergonomically improved working environments or reduced workload, lumbar belts are often used as personal protection equipment. However, their effectiveness on reducing musculoskeletal stress is controversial. Due to the unsatisfactory scientific base of objective statements, this study aims to prove the effectiveness of the Paexo Soft-Back (PSB), a lumbar belt provided by SuitX (Ottobock). Accordingly, the reduction of trunk muscle activity and fatigue of the M. erector spine (ES) as well as postural changes while wearing the PSB were investigated. Twelve healthy participants were instructed to perform three different motion tasks in a random order, both with and without the belt. The tasks are derived from work processes in the field of logistics. Angular changes concerning the trunk- and pelvic tilt, hip-, knee-, and ankle angle were recorded with a motion capturing system (MoCaP) to assess postural changes. Furthermore, electromyography (EMG) was used to measure the activity of the left and right M. erector spine (ES), M. rectus abdominis (RA), M. biceps femoris (BF) and M. rectus femoris (RF) are captured synchronically using surface electromyography (sEMG). For the first task, an individually weighted box was statically lifted at a constrained body posture of 30° trunk flexion. A slight increase of muscular activity can be noticed for both paravertebral muscles, whereas the RA is significantly decreased ($p < 0.05$). The second task comprises of an asymmetrically performed box lift between two tables of different heights. While moving the individually weighted box, a 90° rotation of the body is required. By using a metronome, the lifting frequency is set to 10 lifts per minute for each participant. Assessing the kinematic data, an increased anterior pelvic tilt, as well as hip and knee flexion with the PSB have been measured. However, no significant difference of the integrated EMG (IEMG) were detected either for the up- or down-lifting motion. To assess fatiguing of the ES before and after the asymmetric lift, an 80%-MVC isometric rope pull was conducted to analyze frequency-based changes of the EMG signal. Therefore, the median frequency difference (MDF) was evaluated. Task performance with the PSB significantly decreased signs of fatigue ($p < 0.05$) while performing a repetitive asymmetric lift. Lastly, a sled pull with the weight adjusted to 75% of the body weight was pulled at a self-chosen speed and step length, while maintaining a 30° trunk flexion. The kinematic data shows an increased anterior pelvic tilt and hip flexion with the PSB, while the knee and ankle angles are similar to the task performance without lumbar belt. In terms of the IEMG, a significant decrease of the RA activity ($p < 0.001$) and a slight increase of the myoelectric activity of the ES can be ascertained. The data suggest that the PSB increases the intra-abdominal pressure during all tasks, which contributes to an enhanced stabilization of the spine and reduction of compression between the vertebrae. Moreover, the postural adjustment with the PSB is expected to change the lumbar-pelvic coordination. Based on the measured angles, a slightly lordotic posture can be ascertained, which may support the lumbar-pelvic dynamics, especially during highly straining tasks. However, the data indicates positive effects of the PSB on reducing musculoskeletal risk factors, the lack of similar literature restricts a comprehensive comparison to check the validity. Moreover, some systematic restriction in data capturing both for the MoCap and EMG measurements as well as the small sample size ($n = 12$) further investigations are required.

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