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The efforts in the forearm during the use of anti-vibration gloves in simulated work tasks

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ABSTRACT

The objective of this article is to analyze the levels of forearm muscular contraction associated with the use of anti-vibration gloves, in which the contraction levels with gloves and without gloves are compared. Two different vibrating tools – a Bosch Compact Duty Multi-Cutter and a Bosch Rotary Hammer carrying an Ø20 mm bit – were used in a simulated work environment. Standard operations were performed by each subject ($n = 14$) in an 80 × 40 mm pine bar (cross-sectional cuts with the Multi-Cutter) and on a concrete slab 2 × 2 m, 70 mm thick (20 mm holes with the Rotary Hammer). The forearm muscular efforts were measured by surface electromyography (EMG) in four different muscles: *the flexor digitorum superficialis* (FDS), *flexor carpi ulnaris* (FCU), *extensor carpi radialis longus* (ECRL) and *extensor carpi ulnaris* (ECU). For the flexor muscles (FDS and FCU), a decrease tendency ($p > 0.05$) in the measured EMG was observed when the operations are performed with gloves relative to the bare hand (a reduction of 5–23% in the percentage of maximum voluntary exertion (%MVE)). For the extensor muscles (ECU), a tendency toward increased ($p > 0.05$) muscular contraction was observed when the operations were performed with gloves (an increase of 3–20% in the %MVE). No such tendency was found in the ECRL muscle. The ECU was the muscle with the highest %MVE for 10 and 11 operators ($n = 14$), during the operations, respectively, with the Multi-Cutter and the Rotary Hammer. As a final conclusion from the study, anti-vibration gloves may increase forearm fatigue in the posterior forearm (ECU muscle) and decrease forearm fatigue in the FDS muscle during operations with the above-mentioned tools.

Relevance to industry: Anti-vibration gloves have been applied in industry to reduce the vibration transmitted into the hand and arms through the palms and fingers. This study analyzed forearm muscular efforts during simulated work tasks performed with two different vibrating tools, operated with the bare hand and with three different gloves, based on the analysis of EMG data.

1. Introduction

Prolonged occupational exposure to hand-transmitted vibration has been associated with many forms of upper-extremity health disorders. Hand-arm vibration (HAV) is caused by vibration that is transmitted to the hand and arms through the palms and fingers. Workers who are regularly exposed to excessive hand-arm-transmitted vibration may suffer in the long term with vascular disorders (Raynaud's syndrome), neurological disorders, carpal-tunnel syndrome and musculoskeletal disorders of the hand and arm (e.g., hand-transmitted arm vibration disorders/injuries are recognized occupational diseases in several European countries) (Griffin et al., 2006). The percentage of workers exposed to hand-tool vibration varies between 4.6% and 10.9% among countries such as Germany, Spain, France and Finland (Eashw, 2008). The most prevalent exposure is found in construction (63% of workers), manufacturing and mining (44%), and agriculture and fishing (38%). With respect to construction, the greatest concern is posed by the use of vibrating hand-held tools (DiDomenicoa and Nussbaumb, 2008). Cases of Raynaud's syndrome rank fifth on the list of the most common European occupational diseases recognized in 2001 (Karjalainen and Niederlaender, 2004). An incidence rate of 2.0/100,000 workers was recognized in 2003, particularly in the mining and quarrying activities (Cabeças, 2006). The presence of carpal-tunnel syndrome (CTS) in 125 forestry workers with exposure to vibration was clinically examined through electromyography. In 25 forestry workers, CTS was diagnosed (Koskimies et al., 1990). Vibration is a known risk factor for CTS. In one study on data from the National Health Interview Survey, Tanaka et al. analyzed the relationship between occupational and non-occupational factors and CTS, whereby they found that repetition and vibration remain

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