Superimposed local vibration enhances fatigue resistance without modifying muscle activity or perceived effort.

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Résumé

INTRODUCTION: Superimposed local vibration (SLV) targeting muscle spindles has been shown to transiently facilitate motor unit recruitment and enhance force production during submaximal contractions (1). Conversely, repeated spindle activation during voluntary contractions reduces support to the α-motoneurons, leading to fatigue and strength loss (2). Thus, applying SLV during fatiguing submaximal contractions delay the decline in strength (known as "performance fatigability"). This study investigated the effects of SLV in both men and women during an intermittent, fatiguing knee extension task at low and moderate contraction intensities.

METHOD: A total of 50 healthy adults (29 men: 22 ± 2 yr, 178 ± 6cm, 71 ± 7kg and 21 women: 21 ± 3 yr, 163 ± 5cm, 58 ± 7kg) performed maximal voluntary contraction (MVIC) of the knee extensors and flexors before (PRE) and after (POST), a fatiguing task. The fatiguing protocol consisted of intermittent knee extensions (15s effort, 5s rest) at 50% or 30% MVIC until a 10% strength target loss. The vibration was applied to the quadricipital tendon (100 Hz, 2-3 mm), and participants performed the control task (CON) or the vibration condition (SLV) in random order. The rate of perceived exertion (RPE - Borg10) and the electromyographic activity (EMG) of the vastus lateralis, vastus medialis, and rectus femoris was measured during each contraction. The EMG of the three muscles was summed (EMGQUAD). An ANOVA was used for the Time to exhaustion (TTE), EMGQUAD, and RPE, including *Intensity* (30% vs. 50%) as between-subject factors and *Condition* (CON vs. SLV) as a within-subject factor.

RESULTS: The MVIC in knee flexion and extension decreased from PRE (respectively, 64 ± 18 and 233 ± 74 Nm) to POST (59 ± 18 and 158 ± 53). The maximal EMGQUAD was similarly decreased from PRE to POST in knee flexion ($p = 0.028$) and extension ($p < 0.001$). MVIC and maximal EMGQUAD were not influenced by *Condition* ($p > 0.103$) or *Intensity* ($p = 0.099$). The TTE increased by 9.5 ± 17% with SLV (CON: 191 ± 112s, SLV: 207 ± 127s, $p < 0.001$) without differences between *Intensity* ($p = 0.901$) or S*ex* ($p = 0.183$). The EMGQUAD and the RPE were similar between condition (respectively, $p = 0.233$ and $p > 0.066$). The comparison between intensity logically revealed at 30% MVIC a longer TTE (287 ± 117s compared to 118 ± 33s, $p < 0.001$), a lower EMGQUAD (36 ±

*Intervenant

9% of maximal EMGQUAD compared to 56 ± 11%, $p < 0.001$) but a similar RPE ($p = 0.259$). The EMGQUAD and RPE increases in time (i.e. 0%, 25%, 50%, 75%, and 100% of the TTE) was similar between *Condition* ($p > 0.717$). No correlation was found between TTE SLV relative gain and the maximal relative strength ($p = 0.575$).

DISCUSSION: We found that SLV effectively extends endurance at low to moderate intensities. The prolonged effort was not associated with changes in electromyographic activity or the rate of perceived exertion. Additionally, despite a longer duration of exercise with SLV, the reduction in maximal strength and electromyographic activity following the fatiguing task was similar across all conditions. Moreover, its positive effect remains consistent regardless of maximal force, suggesting that SLV's influence is independent of individual strength levels.

CONCLUSION: Superimposed local vibration seems to be an effective way to extend effort duration, prompting questions about the physiological mechanisms responsible for this effect.

(1) Grande et al., (2003). Ia afferent input alters the recruitment thresholds and firing rates of single human motor units. *Exp Brain Res.* 150(4), 449-457.

(2) Macefield et al., (1991). Decline in spindle support to alpha-motoneurones during sustained voluntary contractions. *J Physiol.* 440(1), 497-512.