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Comparison of EMG Normalization Techniques Recommended for Back Muscles Used in Ergonomics Research

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Abstract : Normalization of electromyography (EMG) data in ergonomics research is a prerequisite for interpreting the data. Normalizing accounts for variability in the data due to differences in participants' physical characteristics, electrode placement protocols, time of day, and other nuisance factors. Typically, normalized data is reported as a percentage of the muscle's isometric maximum voluntary contraction (%MVC). Various MVC techniques have been recommended in the literature for normalizing EMG activity of back muscles. This research tests and compares the recommended MVC techniques in the literature for three back muscles commonly used in ergonomics research, which are the lumbar erector spinae (LES), latissimus dorsi (LD), and thoracic erector spinae (TES). Six healthy males from a university population participated in this research. Five different MVC exercises were compared for each muscle using the Tringo wireless EMG system (Delsys Inc.). Since the LES and TES share similar functions in controlling trunk movements, their MVC exercises were the same, which included trunk extension at -60°, trunk extension at 0°, trunk extension while standing, hip extension, and the arch test. The MVC exercises identified in the literature for the LD were chest-supported shoulder extension, prone shoulder extension, lat-pull down, internal shoulder rotation, and abducted shoulder flexion. The maximum EMG signal was recorded during each MVC trial, and then the averages were computed across participants. A one-way analysis of variance (ANOVA) was utilized to determine the effect of MVC technique on muscle activity. Post-hoc analyses were performed using the Tukey test. The MVC technique effect was statistically significant for each of the muscles ($p < 0.05$); however, a larger sample of participants was needed to detect significant differences in the Tukey tests. The arch test was associated with the highest EMG average at the LES, and also it resulted in the maximum EMG activity more often than the other techniques (three out of six participants). For the TES, trunk extension at 0° was associated with the largest EMG average, and it resulted in the maximum EMG activity the most often (three out of six participants). For the LD, participants obtained their maximum EMG either from chest-supported shoulder extension (three out of six participants) or prone shoulder extension (three out of six participants). Chest-supported shoulder extension, however, had a larger average than prone shoulder extension (0.263 and 0.240, respectively). Although all the aforementioned techniques were superior in their averages, they did not always result in the maximum EMG activity. If an accurate estimate of the true MVC is desired, more than one technique may have to be performed. This research provides additional MVC techniques for each muscle that may elicit the maximum EMG activity.

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