continuously distributed conduction velocities (1), found associations between the spectral properties of sEMG and motor unit recruitment strategies: changes in spectral properties were associated with the level of activation when motor units were recruited in an orderly fashion (single-task manner); however, when recurrent inhibition changed the recruitment patterns (as could happen for multi-task actions) then more pronounced changes in sEMG spectra were observed.

The evidence demonstrates that sEMG certainly can characterize MU recruitment strategies and active fiber types. However, it is likely that this will not necessarily be the case for all physiological situations and restricted recruitment tasks.

REFERENCES

1. **Farina D.** Counterpoint: Spectral properties of the surface EMG do not provide information about motor unit recruitment strategies and muscle fiber type. *J Appl Physiol*; doi:10.1152/japplphysiol.90598.2008a.
2. **Hodson-Tole E, Wakeling JM.** Variations in motor unit recruitment patterns occur within and between muscles in the running rat (*Rattus norvegicus*). *J Exp Biol* 210: 2333–2345, 2007.
3. **Kupa EJ, Roy SH, Kandarian SC, de Luca CJ.** Effects of muscle fiber type and size on EMG median frequency and conduction velocity. *J Appl Physiol* 79: 23–32, 1995.
4. **von Tscharner V, Nigg BM.** Point: Spectral properties of the surface EMG can characterize motor unit recruitment strategies and muscle fiber type. *J Appl Physiol*; doi:10.1152/japplphysiol.90598.2008a.
5. **Wakeling JM, Syme DA.** Wave properties of action potentials from fast and slow motor units. *Muscle Nerve* 26: 659–668, 2002.
6. **Wakeling JM.** Patterns of motor recruitment can be determined using surface EMG. *J Electromyogr Kinesiol.* In press.

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THE MOST CONSISTENT FINDING IN SEMG IS INCONSISTENT FINDINGS

TO THE EDITOR: Our paper was cited by Farina (1) to support the lack of relationship between surface electromyographic (sEMG) spectral variables and motor unit behavior. We reported no significant increase in mean power frequency (MF) with increases in isometric elbow flexion force from 40 to 80 percent of maximal voluntary contraction (MVC) (2). However, it is possible to find other studies wherein the increase in MF is moderate but others demonstrate a large increase in MF across force levels. For example, Sbriccoli et al. (4) demonstrated a large increase in median power frequency (MDF) and muscle fiber conduction velocity during ramp increases in isometric elbow flexion force. It has been suggested that MDF increase reflects the recruitment of higher threshold motor units. It also generally accepted that firing rate characteristics dominate the lower end of the frequency spectrum between 10 and 40 Hz (3). Since the sEMG bandwidth trails off appreciably by 200 Hz, the low frequency band between 10 and 40 Hz represents a significant proportion of the total power. In the absence of changes in conduction velocity associated with fatigue, we showed that changes in firing rate characteristics can impact the MNF to an appreciable degree, causing spectral compression. Thus our experimental and modeling work is in agreement with von Tscharner and Nigg (6).

REFERENCES

1. **Farina D.** Counterpoint: Spectral properties of the surface EMG do not provide information about motor unit recruitment strategies and muscle fiber type. *J Appl Physiol*; doi:10.1152/japplphysiol.90598.2008a.
2. **Gabriel DA, Kamen G.** Experimental and modeling investigation of spectral compression of biceps brachii SEMG activity with increasing levels of force. *J Electromyogr Kinesiol.* In press.
3. **Lago PJ, Jones NB.** Low-frequency spectral analysis of the EMG. *Med Biol Eng Comput* 19: 779–782, 1981.
4. **Sbriccoli P, Bazzucchi I, Responi A, Bernardi M, De Vito G, Felici F.** Amplitude and spectral characteristics of biceps brachii sEMG depend upon speed of isometric force generation. *J Electromyogr Kinesiol* 13: 139–147, 2003.
5. **von Tscharner V, Nigg BM.** Point: Spectral properties of the surface EMG can characterize motor unit recruitment strategies and muscle fiber type. *J Appl Physiol*; doi:10.1152/japplphysiol.90598.2008.

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IT IS NOT A WAVELET ANALYSIS

TO THE EDITOR: von Tscharner and Nigg (6) argue that the orderly recruitment of motor units can be revealed from the intensity pattern generated by a so-called “wavelet” analysis. However, the “wavelet” analysis of Ref. 5, which possesses none of the properties of a wavelet analysis (2), cannot resolve the subtle changes in the EMG recordings that could separate the different types of motor units. Aside from the common, but incorrect, assumption that there exist distinct types of motor units (1, 4), the interpretation of the “wavelet” coefficients defined in (4) is obfuscated by several factors. First, the “wavelet” transform has a poor time resolution. Because the wavelets are computed by taking the inverse Fourier transform of a series of overlapping bumps, the resulting functions have an infinite extent and are imprecise in the time domain. Second, the frequency resolution is poor because any frequency in the range [0:50] Hz is covered by many bumps, and an oscillatory signal, such as the surface EMG, has its energy spread across many different “wavelet” coefficients. This well-established limitation of wavelet analysis (3) is aggravated here because of the ad hoc design of the wavelets. Third, the mathematical interpretation of the so-called “intensity in time space” is completely unclear. As a result, von Tscharner and colleagues cannot assess the statistical significance of the “wavelet intensity” and have resorted to anecdotal visual inspection of the data as validation of the approach.

REFERENCES

1. **Bigland-Ritchie B, Fuglevand AJ, Thomas CK.** Contractile properties of human motor units: Is man a cat? *Neuroscientist* 4: 240–249, 1998.
2. **Mallat S.** *A Wavelet Tour of Signal Processing*. New York: Academic, 1999.
3. **Meyer FG, Coifman RR.** Brushlets: steerable wavelet packets. In: *Beyond Wavelets*, edited by Welland G. New York: Academic, 2003.
4. **Van Cutsem M, Feiereisen P, Duchateau J, Hainaut K.** Mechanical properties and behaviour of motor units in the tibialis anterior during voluntary contractions. *Can J Appl Physiol* 22: 585–597, 1997.
5. **von Tscharner V.** Intensity analysis in time-frequency space of surface myoelectric signals by wavelets of specified resolution. *J Electromyogr Kinesiol* 10: 433–445, 2000.
6. **von Tscharner V, Nigg BM.** Point: Spectral properties of the surface EMG provide information about motor unit recruitment and muscle fiber type. *J Appl Physiol*; doi:10.1152/japplphysiol.90598.2008.

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