Intrinsic hand muscles: unexpected differences in fatigue-associated EMG-behaviour

C. Zijdewind and D. Kernell

Department of Neurophysiology, Academisch Medisch Centrum, University of Amsterdam, Meibergdreef 15, 1105 AZ Amsterdam, The Netherlands

Introduction

Small muscles of the human hand are often used for the study of neuromuscular fatigue. We have been investigating the fatigue-associated electromyographic (EMG) behaviour of two frequently used muscles: the *adductor pollicis* (AP; adductor of the thumb) and the *first dorsal interosseus* (FDI; abductor of the index finger). These muscles are known to differ in their histochemical fibre-type composition; AP has about 80% type I fibres, whereas FDI has a more evenly balanced composition (57% type I fibres, Johnson et al. 1973). Therefore one might expect a difference in fatigue-associated EMG behaviour between AP and FDI.

Methods

The results were obtained from the right hand of 16 healthy right-handed volunteers (8 male, 8 female). The hand and forearm of the subjects were immobilized with pressure plates and velcro tape, while the index finger was positioned at an angle of about 80% of maximal abduction. Transcutaneous electrical stimulation was given to the ulnar nerve (0.1 ms pulses, 50% supramaximal intensity). The fatigue test consisted of bursts (30 Hz; 10 pulses) repeated once a second during 5 minutes. During the fatigue test force recordings were made for thumb (adduction) and index-finger (abduction/adduction, flexion). Monopolar EMG recording electrodes were attached to the skin overlying the AP and the FDI belly. Measurements of EMG reactions during fatigue tests concerned peak-to-peak amplitude and half-area (area of the first negative peak) of compound action potentials (M-waves), as analyzed for the first and tenth M-wave of each burst.

TABLE 1. Fatigue-associated EMG-behaviour in AP and FDI, as measured for the first M-wave of each burst in different groups of subjects.
*All values are expressed as ratios (%) of measurements obtained at the end of a fatigue test vs. those for the initial burst. Significance of differences for AP vs. FDI (paired t test) and for male vs. female (t test) indicated by: ** for $P<0.01$, * for $P<0.05$, ns for not significant, i.e. $P>0.05$).*

	--- M-wave amplitude ---			--- M-wave half-area ---		
	AP	AP vs FDI	FDI	AP	AP vs FDI	FDI
All subjects	94	ns	90	97	ns	90
Male (M)	107	**	89	110	*	99
Female (F)	81	*	90	82	ns	81
M vs F	**		ns	**		ns

Results

When analyzing the EMG recordings for all subjects together, no significant differences were found between FDI and AP (Table 1). However, when considering the results for male and female subjects separately, significant differences became apparent:

1) between AP and FDI of the same individuals (Table 1), and

2) between males and females for the same muscles, this was valid for FDI initially (Fig. 1) and for AP later on during the test (Table 1, Fig.1).

When analyzed at corresponding times within the fatigue tests, no significant differences were found between males and females with respect to the fatigue-associated drop in the force of thumb adduction (AP contraction). Forces of the index finger, as caused by electrical ulnar-nerve stimulation, are of complex origin and will be dealt with elsewhere (Zijdewind and Kernell, in preparation).

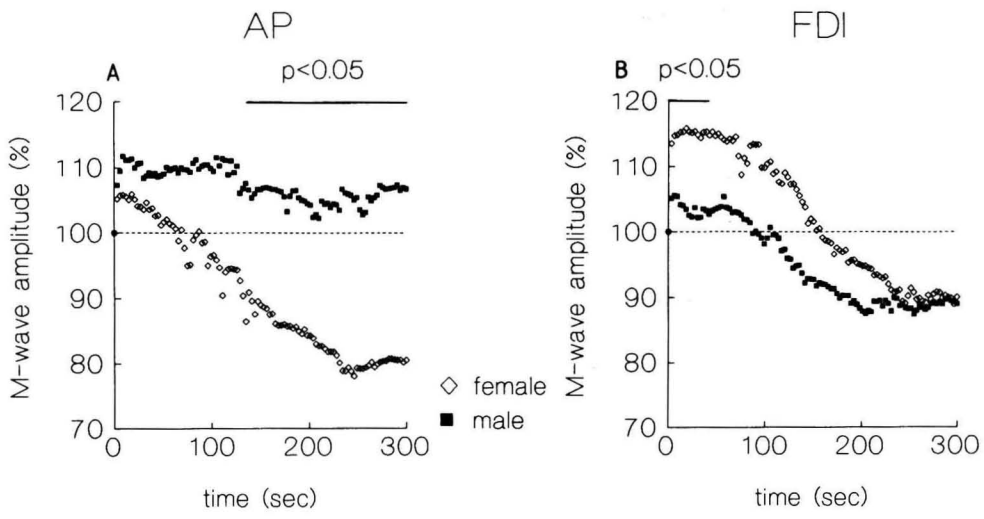

Figure 1. Relative changes in M-wave amplitude (% of initial value; first M-wave per burst) during simultaneous fatigue tests of AP and FDI. Means plotted for males (n=8) and females (n=8). Times during which values of males and females were significantly different from each other indicated by bars (paired t tests, $P<0.05$).

Discussion

In accordance with our general expectations, differences were indeed found between the fatigue-associated EMG reactions of AP and FDI. The observed differences between males and females were, however, completely unexpected. Further studies will be necessary for establishing whether these differences were caused by truly sex-linked variations in muscle characteristics or whether other sex-associated factors were of influence on the EMG recordings (e.g. possible effects on recording situation of differences in hand size, possible differences in local temperature control, etc.).

Reference

Johnson MA, Polgar J, Weightman D & Appleton D (1973). Data on the distribution of fibre types in thirty-six human muscles. An autopsy study. *Journal of the Neurological Sciences* **18**, 111-129.