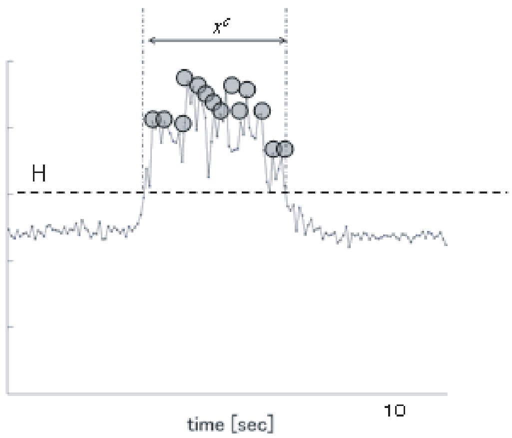

Fig. 5. A series of maximal values of the ARS during the muscular contraction periods in the BFT were extracted by our mathematical algorithm of the sensor output signal evaluation system.

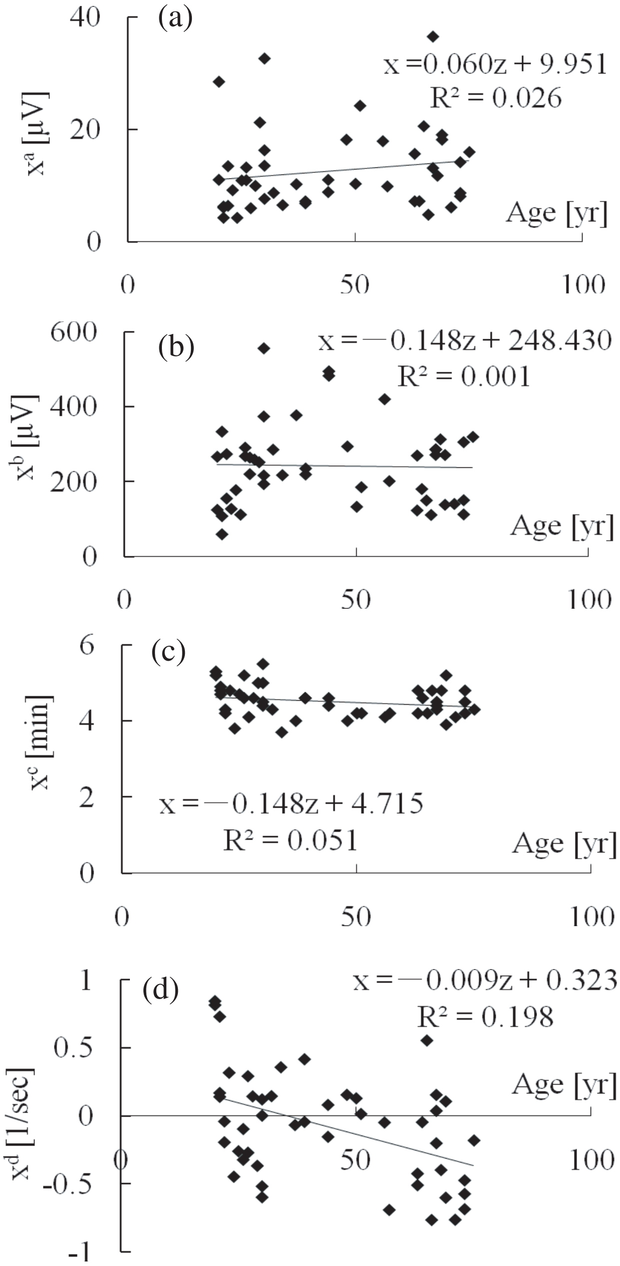

Fig. 6. Relationships between the measurement parameters of the ARS and age and their linear regressions. R^2 shows the coefficient of determination. MARS during the muscular relaxation period, x^a (a). Maximum amplitude, x^b (b). Duration of continuous muscular contraction, x^c (c). Time constant of the exponential curve fit to the maximal points of the continuous muscular contraction period, x^d (d).

tile amplifier and recorder (Polymate AP1532, TEAC Co.), and electromyographic electrodes (bipolar) with a preamplifier were used.

First, the electromyographic wave patterns obtained over several seconds at the maximum effort of the kicking motion (maximum voluntary contraction (MVC) (Carlo and Deluca, 1997) were integrated in real time using a computer, and the ARS data on the display were shown to the subject. Next, the threshold line at 75% of the mean ARS (mV) during the muscular contraction period was shown to the subject, who was requested to perform muscular training aiming at the threshold line for 1 min 20 s. In other words, BFT was performed at 75% of the MVC. During BFT, data were recorded in a notebook computer (AP Monitor, NoruPro) at a sampling rate of 2 kHz. The low frequency cut-off filters were used at 16 Hz, and an alternating current-eliminating filter was also used.

2.4 Calculation procedure

The initial 20 s of the sEMG data recorded over a total of 1 min 20 s were excluded, because the subjects may have required this time to adjust to the training. The sEMG data of the 6-cycle rectangular waves that occurred over the remaining minutes of training (target value) $f(t)$ and the ARS were analyzed in accordance with the Double-Wayland algorithm (Takada *et al.*, 2006a) and our own mathematical algorithms of the sensor output signal evaluation system (Shiozawa *et al.*, 2006a, 2007) (Fig. 4). Taking a mean of the ARS (MARS) as a threshold H for determining continuous muscular contractions, the time sequences above the threshold H were regarded as continuous muscular contractions. Based on whether differences such as $x(t)-x(t-0.1)$ and $(x(t+0.1)-x(t))(x(t)-x(t-0.1))$ were positive or negative, a maximal series for the continuous muscular contractions was extracted as shown in Fig. 5.

(a) The value of the MARS during the muscular relaxation period (x^a) and the measurement parameters x^b, x^c, x^d (Shiozawa *et al.*, 2006b, c; Takada *et al.*, 2006b) indicating the shape of the ARS were determined every cycle, and the ARS values obtained from the femoral rectus muscles were evaluated.

(b) Maximum amplitude (x^b): This maximum value was examined and recorded.

(c) Duration of continuous muscular contraction (x^c): The duration between the first and last maximal values in a cycle exceeding the MARS sEMG was measured (Fig. 5).

(d) The time constant of the exponential decay curve fit to the maximal points during the muscular contraction period in the BFT (x^d): All maximal values between the first and last maximal values exceeding the MARS in a cycle were extracted as $\{x_m(t)\}$ and fit to the exponential decay curve