EFFECT OF RENAL HYPERTENSION ON SLOW AND FAST TWITCH MUSCLES IN RAT

BY

WATTANA JALAYONDEJA

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Wattana Jalayondeja

Department of Physiology, Faculty of Science, Mahidol University
Rama VI Rd., Bangkok 10400, Thailand

ABSTRACT

Reduced hindlimb muscle $O_2$ consumption and blood supply observed in renal hypertensive rats (RHR) may be involved with the decrease in force developed per contraction of the muscle. To explore this possibility, isometric twitch stress ($P_t$), maximum isometric tetanic stress ($P_o$), and endurance to rhythmic contractions of soleus (SOL) and extensor digitorum longus (EDL) muscle were determined in situ in 2-kidney, 1-clip RHR. With the muscle held at their optimal length (L0), both SOL and EDL were stimulated via their motor nerves by square wave electrical pulses of 0.05 msec duration at supramaximal intensity to obtain single twitches and the muscle were tetanized at their optimal frequency to obtain $P_o$. The time to peak tension ($T_p$) and time to half relaxation ($T_{1/2}$) of SOL in RHR are 39.3±2.4 msec (n=18) and 38.5±1.7 msec (n=18), respectively, and are significantly shorter than 48.5±1.5 msec (n=20) $T_p$, and 43.2±1.6 (n=20) $T_{1/2}$ of age-matched normotensive controls (NTR). The twitches of EDL in both NTR and RHR show similar $T_p$, i.e. 23.8±0.7 msec (n=19) and 22.9±1.2 msec (n=15), respectively; but the $T_{1/2}$ is significantly increased from 19.3±0.7 msec (n=19) to 21.7±1.2 msec (n=15) in the RHR group. The $P_t$ and $P_o$ of both types of muscle however, are unaffected by renal hypertension (RHT).
To determine the fatigability of the muscles SOL and EDL were set at their $l_0$ and tetanized isometrically via their motor nerves by trains of 0.05 msec pulses at the optimal frequency for each muscle and at supramaximal intensity. To avoid circulatory impairment, the train were delivered at the frequency of 1 Hz with 0.75 sec duration, thus allowed 0.25 sec rest interval between tetani. The time needed for the tetanic stress to drop to 1/3 of the initial $P_0$ ($T_1/3P_0$) in SOL and EDL are found to be not altered by RHT.

Results from histochemical studies indicate that, the percentage of fast twitch fibers in SOL are significantly increased from 29.3$\pm$1.6% (n=8) to 33.2$\pm$11.1% (n=8) by RHT, whereas that of EDL is unchanged. The percentage of highly oxidative fibers in both SOL and EDL are not altered by RHT. Myoglobin content of EDL from the biochemical assays are significantly increased by RHT, while those of SOL are not altered.

It is indicated that EDL which has high percentage of highly oxidative fibers is fully adapted by the increase in the level of myoglobin content in response to local hypoxia caused by reduced muscle blood supply in RHR. The unchange in level of myoglobin content in SOL which has moderate oxidative capacity indicates the adequate $O_2$ supply to perform its contraction. The changes in $T_p$ and $T_1/2R$ in SOL are results from the increase in percentage of fast twitch fibers and the possible effect of hormonal changes in RHR, whereas the leakage of plasma membrane to calcium and the decrease in rate of calcium uptake to microsomes in EDL muscle cells are speculated to change its $T_1/2R$. 