MHC composition and isometric tension in EDL muscle fibres from Zucker Obese and Zucker Lean rats

R. Blazev[1], J.G. Kemp[1,2], D.G. Stephenson[3], G.M.M. Stephenson[1], [1]School of Biomedical Sciences, Victoria University, Melbourne, VIC, Australia, [2]School of Exercise Science, Australian Catholic University, Melbourne, VIC, Australia, [3]Department of Zoology, La Trobe University, Melbourne, VIC, Australia

The size of the fast-twitch hindlimb muscle[1] and fibre cross-sectional area (CSA)[2] are smaller in the Zucker Obese rat (ZOR) than in the Zucker Lean rat (ZLR). Given the larger body mass of ZORs, one would expect structural/functional differences between muscles/fibres from the two rat groups. To date, little is known about such differences. Here we compared, using a single fibre approach the fibre type composition of extensor digitorum longus (EDL) muscles from ZORs and ZLRs and the isometric tension in individual fibres from the two muscle groups.

Male Zucker rats (10-12 weeks) were killed by halothane overdose according to Victoria University AEEC procedures. Muscle dissection[3], determination of maximum Ca^{2+}-activated force (CaF_{max})[3] and electrophoretic analysis of myosin heavy chain isoform (MHC_i) composition[4] in mechanically skinned fibres were performed as previously described.

The EDL muscles (μg/g body wt) were significantly smaller in ZORs than in ZLRs (254 ± 8.4, n=9 *vs* 453.9 ± 3.7, n=9). Single fibre MHC_i analysis revealed that IIB fibres are the predominant group (>85%) in both ZOR and ZLR muscles. However, the ZOR muscles yielded a smaller proportion of IIB fibres (85.4%, n=82 *vs* 91.4%, n=81) and a larger proportion of hybrid fibres (13.4%, n=82 *vs* 8.6%, n=81). The average CaF_{max} for ZOR-IIB fibres ($3.3 \pm 0.3 \times 10^{-7}$kN, n=10) was 33% lower than that for ZLR-IIB fibres ($4.9 \pm 0.5 \times 10^{-7}$kN, n=11), while the average CSA (μm^2) of ZOR-IIB fibres was 51% smaller than that of ZLR-IIB fibres (766.6 ± 46.1 *vs* 1565 ± 180.6). Thus, CaF_{max}/CSA (kN/m^2) developed by the ZOR-IIB fibres was 31% greater than that of ZLR-IIB fibres (425.5 ± 81.4 *vs* 325.6 ± 89.1; $p<0.05$). These results suggest that in the ZOR (model for type 2 diabetes) there is a fibre type shift in the EDL muscle and a structural/functional change in the contractile apparatus of type IIB fibres.

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(2) Goodman et al. (2003) Am J Physiol Cell Physiol 284:C1448-59
(3) He et al. (1995) Acta Physiol Scand 155:1-7
(4) Durschlag RP & Layman DK (1983) Growth 47:282-91