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The impact of daily work load during pregnancy and/or postnatal life on the heart microstructure of rat male offspring

Auszirkungen täglicher Arbeitsbelastung während der Schwangerschaft und/oder während des postnatalen Lebens auf die Mikrostruktur des Herzens. Untersuchungen an der Nachkommenschaft von Ratten

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With 7 tables

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Summary

The microstructure of the cardiac muscle of four groups of male rats was investigated: control (EC) and exercised (EE) offspring of mothers exercised during pregnancy, and control (CC) and exercised (CE) offspring of inactive control mothers. The differences between groups were subjected to variance analysis and multiple range testing according to Duncan. Total body weight did not differ during the entire experiment. With the exception of the subgroup CE (lower values) the absolute and relative (mg/100 g total B. W.) weight of the cardiac muscle did not differ either. The number of heart fibres and capillaries per mm² was highest in subgroup EE, and significantly lowest in subgroup CC. The capillary: fibre ratio was significantly highest in EE; diffusion distance (D/2) was shortest in EE. Other groups were intermediate. A greater impact of prenatal than postnatal work load on the microstructure of the cardiac muscle of the offspring was demonstrated.

The development of offspring is significantly influenced by various stimuli acting on the fetus during pregnancy as is obvious, for example, in the case of malnutrition of the mother. The consequences are even more marked when the same stimulus is also applied during postnatal ontogenesis. One factor which can act in this way during the fetal period was shown by following up the offspring of hare mothers who were subjected to a work load, i.e. daily swimming during the last third of pregnancy: the cardiac muscle of the newborn of swimming mothers was heavier than of control mothers (1). Some changes obviously resulting from a regular work load during pregnancy are also apparent later on during postnatal ontogeny, as demonstrated in the offspring of rat mothers exercising daily on a treadmill (1 hour mild aerobic exercise). In this case the microstructure of cardiac muscle developed more favourably
in the offspring of exercised mothers (10). Lipid metabolism in the liver and small intestine of offspring was also significantly modified by a regular work load of pregnant rats on a treadmill (15). More pronounced changes can be expected following a work load applied not only during prenatal, but also postnatal ontogenesis. Therefore, the development of cardiac muscle in offspring of both exercised and inactive control rat mothers was investigated after a period of work load during postnatal life.

**Methods**

Young female rats were selected and mated with males (always 4 females with 2 males in one cage) at the age of approximately 120 days. The mean weight of females was 240 g, that of males 410 g. Half of the females were exercised on a treadmill at a speed of 14-16 m/min (i.e. mild exercise of an aerobic character) for one hour per day during the entire pregnancy (11). The weight of the mothers increased to approximately the same value at the end of pregnancy (298 and 316 g). Litters were 9-13 per mother but only 8 offspring were left in each nest during the weaning period which lasted up to the 30th day of life. Only males were used in this experiment, and they were always selected for individual subgroups from at least 5-6 nests. Half of the male rats started exercise on the treadmill after weaning. The final duration and intensity of the daily work load, which was eventually identical to that of the mothers, was achieved after approximately 15-20 days, i.e. at the age of approximately 50 days. The other half of the animals was selected similarly from 5-6 nests and constituted the inactive controls. Finally, there were four subgroups of males. The first group was from exercised mothers and exercised during postnatal ontogenesis (EE). The second group constituted inactive control offspring of exercised mothers (EC); the third group, exercised offspring of control mothers (CE); and the fourth group, inactive control offspring of control mothers (CC).

Total body weight, heart and soleus muscle weight, epididymal fat pads and the characteristics of the microstructure of the heart were evaluated. The heart was prepared according to Fulton et al. (5). Density of capillaries and muscle fibres per mm² were determined histochemically by the PAS reaction (7, 8, 6). Tissue specimens were taken from the same part, i.e. approximately in the middle of the longitudinal axis of the left ventricle and fixed with 19% formol for a period of 3-4 weeks. The number of capillaries and muscle fibres per mm² was counted only in the transverse paraffin sections from 6-12 fields from each heart using a light microscope with a vertical camera (Zeiss). Two other parameters were derived from these measurements, i.e. the capillary: fibre ratio and the diffusion distance (D/2) according to Krogh (9) which is the average half-distance between two capillaries in a cross-section.

Statistical evaluation of the data was performed using variance analysis and multiple range testing (3, 4).

**Table 1.** Mean values, variance analysis, and multiple range test (Duncan) of total body weight in male rats with different physical activity during prenatal and postnatal ontogenesis (EE = exercised offspring of exercised mothers, EC = inactive control offspring of exercised mothers, CE = exercised offspring of inactive control mothers, CC = control offspring of control mothers).

<table>
<thead>
<tr>
<th>Groups</th>
<th>EE</th>
<th>EC</th>
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<tr>
<td>n</td>
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<td>14</td>
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<td>372.9</td>
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