Smoking-induced atrophy and decreased oxidative capacity in mouse diaphragm

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Introduction and Background

Smoking is associated with a reduced exercise capacity. Several studies have shown muscle atrophy and a reduced oxidative capacity in muscle. Little is known, however, about the effects of smoking on the diaphragm muscle. To investigate this we isolated diaphragm muscles from 12 controlled and 13 smoking mice that had been subjected to three months daily nose-smoking only.

Aim: To characterise the mitochondrial oxidative enzyme activity of the diaphragm muscle.

Methods

Cross-sections of the diaphragm muscles were cut (10 µm) with a cryostat at -21°C. Sections were stained for succinate dehydrogenase (SDH) as a measure of the oxidative capacity. Thereto, sections were incubated in 37.5 mM sodium phosphate buffer (pH 7.6), 74 mM sodium succinate and 0.4 mM tetranitro blue tetrazolium in the dark at 37°C for 20 min. On images, the fibre outlines were traced to assess fibre size and the optical density at 660 nm was measured. Serial sections were stained for fibre type with myosin heavy chain-specific antibodies and capillaries with lectin. The number of capillaries and capillary density for each fibre determined.

The SDH activity was lower in the diaphragm of smoking than non-smoking mice (p<0.03). The higher capillary density in the diaphragm of smoking than non-smoking mice (p<0.00) was not due to angiogenesis, as the number of capillaries per fibre did not differ significantly, but by a smaller fibre size (p=0.03).

Results and Discussion

Conclusion: In conclusion, smoking does induce significant atrophy and a reduction in the oxidative capacity in the diaphragm, that will contribute to a reduced exercise capacity in smokers, and over time lead to diaphragm dysfunction and weakness as seen in patients with chronic obstructive pulmonary disease.

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