P108

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The acute physiological response to constant load exercise in end stage renal disease

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Introduction: Maximal exercise capacity (VO2 peak) is reduced by around 50% in end stage renal disease (ESRD), affecting activities of daily living and quality of life. Exercise training is recommended, but the acute physiological response to exercise is incompletely understood, and there are no universally accepted exercise prescription guidelines. In ESRD, we aimed to characterise the acute physiological response to maximal exertion, and sub-maximal constant load exercise.

Methods: 20 people with ESRD and 20 healthy age-matched participants (59 ± 10 yrs) underwent: 1) resting echocardiography and spirometry, 2) maximal cardiopulmonary exercise testing (CPET), and 3) a 30-minute constant load exercise test (CLET) at 90% of anaerobic threshold (AT) i.e. a standard aerobic exercise session. Ventilatory gas exchange and heart rate (HR) were measured throughout. Haemodynamics were continuously monitored during CLET with non-invasive thoracic bioreactance.

Results (table 1): Compared to healthy participants, lung capacity was decreased, and left ventricular (LV) diastolic function impaired in ESRD. Despite beta-blockade (n=11 ESRD), HR rest was higher in ESRD. VO2 peak and O2 uptake at AT (VO2 AT) were pathologically reduced in ESRD, and HR response was attenuated.

During CLET, %VO2 peak was the same in both groups, whilst %HR peak and %VE peak were higher in ESRD. The relative increase (%) from rest in cardiac output was the same in both groups. However, in ESRD, this was achieved via a large relative increase in LV stroke volume, and a small relative increase in HR; the inverse was true for healthy participants.

Discussion: VO2 peak and VO2 AT were 50% lower in ESRD than in healthy participants, indicating cardiopulmonary and metabolic impairment and deconditioning. Diastolic LV dysfunction and poor lung capacity both likely contribute to this finding. HR response during CPET was grossly abnormal, unexplained by beta-blockade alone, thus strongly suggestive of autonomic dysfunction.

At 90% VO2 AT, constant load exercise was comfortably sustained for 30 mins in ESRD, but performed at a higher physiological cost relative to peak CPET values. In the absence of an appropriate HR response during CLET, increased cardiac output was primarily reliant on augmented stroke volume, further indicative of autonomic dysfunction.

Conclusion: Despite severe physiological limitation during maximal and sub-maximal exercise (primarily autonomic dysfunction in our data), 30 mins of continuous aerobic exercise was well tolerated in ESRD. Exercise training should be prescribed accordingly, to increase functional capacity and improve quality of life in ESRD.