Attenuation of the Threshold for Myocardial Ischemia in Ramp vs Standard Bruce Protocol in Patients with Positive Exercise Stress Test and Angiographically Demonstrated Coronary Artery Narrowing?

Noël Martin, Jean Jobin, Audrey Marcoux, Luce Boyer, Gilles R Dagenais, Peter Bogaty, Institut de cardiologie et de pneumologie de l'Université Laval, Hôpital Laval, Québec, Qc, Canada

Background: Gradual instead of abrupt increases in workload favour a more physiological response in terms of hemodynamic and gas exchange parameters. Therefore, we sought to determine whether myocardial ischemia is attenuated with a ramp compared to a standard Bruce exercise protocol in patients with coronary artery disease (CAD).

Methods: We compared ischemic parameters on the Bruce protocol with an individualized ergocycle ramp protocol in 18 men with documented CAD ($\geq 70\%$ stenosis) and a reproducible ischemic ECG exercise test. These 2 symptom-limited tests were performed in random order 2 weeks apart. Oxygen consumption (VO_2), ischemic threshold [systolic blood pressure $\times$ heart rate (RPP) at 1 mm ST-segment depression], and maximum ST-segment depression corresponding to the highest RPP common to the 2 tests (AdjSTmax) were determined.

Results: While all subjects showed ischemia on the treadmill, 6/18 did not on the ergocycle. However, ischemic threshold was higher on the ramp than the Bruce protocol ($23\,420 \pm 5\,732$ vs $20\,018 \pm 3\,542$ $\text{bpm} \cdot \text{min}^{-1} \cdot \text{mmHg}$; $P=0.007$). Peak RPP was higher during the ramp than with the Bruce protocol ($28\,492 \pm 6\,450$ vs $25\,519 \pm 6\,067$ $\text{bpm} \cdot \text{min}^{-1} \cdot \text{mmHg}$, respectively; $P=0.02$), despite similar peak VO_2 (25.59 ± 5.05 vs 26.39 ± 4.65 $\text{mlO}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, respectively; $P=0.6$). AdjSTmax was less on the ramp than the Bruce protocol (-1.2 ± 0.9 vs -1.9 ± 0.7 mm; $P=0.003$).

Conclusion: Exercise-induced myocardial ischemia is markedly attenuated on the more gradually increasing workload of the individualized ramp ergocycle compared with the standard Bruce treadmill protocol. This

effect is unexplained by energy expenditure (VO_2) or myocardial work (RPP) and is consistent with a "warm-up" ischemic mechanism. The more gradually increasing workload of the ramp ergocycle protocol may have favoured a "warm-up" ischemic effect despite achieving higher RPP than the Bruce protocol treadmill suggesting it may be physiologically preferable for exercise prescription in patients with CAD.

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Role of Functional Indicators in the Multifactorial Pathologies in Cardiopulmonary Rehabilitation

Pulici Sergio, Piergiorgio Schiavoni, Hospital San Giuseppe Rehabilitation Medicine, Milano, Italy

Background: Patients in cardiopulmonary rehabilitation often complain of exercise intolerance. While ventilatory limitation is often present, other factors are also important: cardiovascular deconditioning, respiratory muscle dysfunction, gas exchange abnormalities and ventricular dysfunction.

Methods: Forty patients, hospitalized for a consecutive 6 month-period, with persistent exercise intolerance due to cardiopulmonary pathologies were included. 90% were COPD II to IV GOLD stage; 5% had chronic cardiac decompensation; 5% had undergone surgery for coronary bypass and/or cardiac valve prosthesis. Patients were excluded who were clinically unstable, unable to cooperate correctly, had arrhythmia due to atrial fibrillation and/or receiving beta-blocking therapy. We have, furthermore, measured parameters of ventilatory dysfunction (ventilatory reserve, dynamic inspiratory capacity), the parameters of cardiovascular limitation (peak heart rate and recovery heart rate at the first minute), parameters of respiratory muscles dysfunction (maximal inspiratory pressure and at the end of the 6 min walking test). Afterwards we classified patients into three groups: ventilatory-limited, cardiovascular-limited, respiratory muscles-limited.

Results: Exercise performance limitation resulted from ventilatory limitation in 60% of the patients, second by cardiovascular limitation in 30% of the

patients and also by respiratory muscle limitation in 10% of the patients.

Conclusions: Based on admission diagnosis of 40 patients, 90% were defined as subject to pulmonary rehabilitation and in 10% were receiving cardiac rehabilitation. They divided into three specific functional recovery programs: ventilatory function recovery program (60%), cardiac function recovery program (30%), respiratory muscles recovery program (10%).

Leg Muscle Blood Flow During 1 and 2-Leg Knee Extension Exercise in Patients with COPD and Aged-Controls

Robillard Julie, Fatihat Momoh, Jacinthe Baril,

Montreal, Quebec, Canada

Andrew William Sheel, Vancouver, British-Columbia, Canada

Robert Boushel, David Laurin, Amanda Rossi, Julie Deschênes, Jean Bourbeau, Tanja Taivassalo, Hélène Perrault, Montreal, Quebec, Canada

Background: In chronic obstructive pulmonary disease (COPD), leg muscle blood flow may be compromised during dynamic exercise due to the competing influence of respiratory muscle work for available cardiac output. This study examined the flow demand limits of skeletal muscle flow in varying muscle mass recruitment. It employed one leg knee extension (1L-KE) and two-leg knee extension (2L-KE) to examine the mass-specific work rates at which peripheral circulatory function may become compromised due to elevated respiratory demands.

Methods: Three male COPD patients (70 ± 5 yr; $FEV_1/FVC = 42 \pm 11\%$) and two aged-controls (74 ± 1 yr; $FEV_1/FVC = 76 \pm 5\%$) completed three sets of 7-minute steady state 1L-KE and 2L-KE at 20, 40 and 65% (SS20%; SS40%; SS65%) of previously determined ergometer-specific peak power, separated by rest periods of 15 min. Leg muscle blood flow (BF) was determined using pulsed Doppler sonography of the femoral artery during incremental exercise loads and post-exercise. ECG, blood pressure, ventilatory parameters and VO_2 were obtained continuously, and

dye dilution cardiac output was measured at rest and during exercise.

Results: Preliminary data showed that, for each exercise intensity, the required VO_2 is similar in both groups. However, the workloads in COPD are between 60% and 82% of the control group workloads. During 1L-KE and 2L-KE, BF is consistently higher in COPD compared to controls. For 1L-KE, the increase in BF from rest (mean $\pm$ SD in ml/min; COPD vs controls) are SS20%: 763 ± 244 vs 105 ± 34 ; SS40%: 1157 ± 597 vs 310 ± 97 ; SS65%: 1493 ± 348 vs 424 ± 45 . BF relative to workload is at least 3-fold higher in COPD compared to controls for all exercise intensities.

Conclusions: These data suggest that mean muscle blood flow may not be compromised during knee-extensor exercise in COPD patients, and ongoing data will clarify whether this is a compensatory response to altered peripheral muscle metabolic function.

A Written Action Plan for Early Treatment of COPD Exacerbations: An Important Component to the Reduction of Hospitalizations

Sedeno Maria F, MM, Respiratory Epidemiology and Clinical Research Unit, Montreal Chest Institute, McGill University, Montréal, Québec, Canada

Diane Nault, MSc, Respiratory Epidemiology and Clinical Research Unit, Montreal Chest Institute, McGill University and Chronic Obstructive Pulmonary Disease axis of the Respiratory Network, Fonds de la Recherche en Santé du Québec (FRSQ), Montréal, Québec, Canada

Dina H. Hamd, PhD, Respiratory Epidemiology and Clinical Research Unit, Montreal Chest Institute, McGill University, Montréal, Québec, Canada

Jean Bourbeau, MD, Respiratory Epidemiology and Clinical Research Unit, Montreal Chest Institute, McGill University and Chronic Obstructive Pulmonary Disease axis of the Respiratory Network, Fonds de la Recherche en Santé du Québec (FRSQ), Montréal, Québec, Canada

Background: This study explored the role of a written action plan in reducing hospitalizations as a com-