

PULMONARY AND PERIPHERAL DETERMINANTS OF EXERCISE CAPACITY IMPROVEMENTS AFTER VENOUS RECANALIZATION

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Abstract

Background:

Post-thrombotic syndrome (PTS) is a chronic complication of deep vein thrombosis associated with persistent dyspnea, exercise intolerance, and reduced quality of life. Although venous recanalization may improve symptoms and venous return in patients with chronic venous obstruction, the physiological mechanisms underlying exercise limitation and the effects of recanalization on exercise cardiopulmonary responses remain insufficiently characterized. We therefore aimed to evaluate the impact of venous recanalization on exercise capacity, central hemodynamics, and pulmonary vascular responses during exercise in patients with chronic venous obstruction.

Methods:

We conducted a prospective pre-post interventional study in patients with symptomatic chronic venous obstruction undergoing venous recanalization. Participants underwent standardized physiological evaluation before and after intervention, including cardiopulmonary exercise testing with breath-by-breath gas exchange analysis, thoracic impedance-derived cardiac output monitoring, and pulmonary diffusion assessment using combined DLNO/DLCO measurements. The primary outcome was peak oxygen uptake ($V'O_2$ peak). Secondary outcomes included exercise cardiac output (CO), oxygen extraction parameters, ventilatory responses, and pulmonary vascular adaptations during exercise.

Results:

Venous recanalization was associated with improved exercise capacity, reflected by an increase in $V'O_2$ peak from 19.49 ± 4.56 to 22.49 ± 4.64 mL·kg⁻¹·min⁻¹ after intervention (95% CI 1.42–4.58; $p < 0.001$). Maximal aerobic power also increased significantly (111 ± 28.7 vs 127 ± 34 W; $p < 0.001$). No significant change in exercise cardiac output was observed after intervention (7.25 ± 1.08 vs 6.98 ± 0.80 L·min⁻¹; $p = 0.48$), suggesting that the improvement in $V'O_2$ peak may involve mechanisms other than enhanced convective oxygen delivery. A significant increase in the first ventilatory threshold (VT1) was also observed, suggesting improved submaximal exercise tolerance following recanalization. In parallel, pulmonary vascular responses during exercise appeared modified after intervention, with a decrease in post-exercise DLNO/DLCO ratio (5.72 ± 0.87 vs 5.14 ± 1.03 ; $p = 0.03$) together with a trend toward increased pulmonary capillary blood volume, suggesting enhanced pulmonary capillary recruitment during exertion.

Conclusion:

Venous recanalization may improve exercise capacity in patients with chronic venous obstruction and PTS. The absence of a clear increase in exercise CO suggests that peripheral or pulmonary vascular adaptations may play an important role in the physiological response to intervention.

Topic/s:Physiologie respiratoire

Vaso-occlusive complications and longitudinal decline in FEV₁ in adults with sickle cell disease

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Introduction:

Respiratory involvement is a major cause of morbidity and premature mortality in adults with sickle cell disease (SCD). Spirometric abnormalities are frequent, and these patients may experience accelerated decline in forced expiratory volume in one second (FEV₁). However, the determinants of this accelerated decline remain poorly understood. Acute vaso-occlusive complications, including vaso-occlusive crises (VOC) and acute chest syndrome (ACS), may contribute to lung remodeling and therefore represent a potentially relevant mechanism. This study aimed to assess the impact of vaso-occlusive complications on longitudinal changes in FEV₁ z-score in adults with SCD.

Methods:

A retrospective single-center observational study was conducted at Nantes University Hospital, including adults with major sickle cell syndromes (SS, SC, Sβ⁰, Sβ⁺) followed between 2014 and 2025. Eligible patients had at least three forced spirometry tests with grade A or B quality FEV₁ measurements during follow-up, as well as documented acute vaso-occlusive complications. Patients were stratified according to the occurrence of ACS and VOC frequency (<4/year versus ≥4/year). Clinical, biological, radiological, and echocardiographic data were collected from medical records. Spirometric z-scores were calculated using the Global Lung Initiative 2012 reference equations. The primary outcome was the annual slope of FEV₁ decline, expressed as z score/year and estimated using simple linear regression.

Results:

A total of 82 patients with major sickle cell syndromes were included, with a median [Q1; Q3] of 5 [3; 6] spirometry tests per patient and a median follow-up of 6.8 [4.2; 8.9] years. Median age at inclusion was 28.2 [23.6; 37.1] years, and 64.6% of patients were women. Abnormal pulmonary function tests were observed in 31% of patients, mainly suggestive of a potential restrictive pattern. The median annual change in FEV₁ z-score was 0.00 [-0.05; 0.07]/year. No significant difference in FEV₁ trajectory was observed according to VOC frequency or ACS occurrence. Median FEV₁ z-score slopes were 0.00, 0.04, 0.01, and -0.03/year in the ACS–VOC<4/year, ACS–VOC≥4/year, ACS+VOC<4/year, and ACS+VOC≥4/year groups,

respectively ($p=0.239$). Similarly, no significant association was found between vaso-occlusive complications and longitudinal changes in FVC or FEV₁/FVC ratio.

Conclusion:

In this retrospective cohort of adults with sickle cell disease, acute vaso-occlusive complications were not associated with a significant acceleration of respiratory function decline. These findings suggest that other mechanisms may contribute to chronic respiratory impairment in adults with major sickle cell syndromes. Further longitudinal studies are needed to identify the determinants of respiratory decline in this population.

Topic/s: Physiologie respiratoire

Effects of training on the alveolar-capillary diffusion capacity at exercise in patients with fibrotic interstitial lung diseases

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Introduction: In patients with fibrotic Interstitial Lung Diseases (f-ILDs), exercise capacity is mainly limited by constraint breathing due to mechanical impairment, and by alteration of the alveolar-capillary diffusion capacity. Exercise training can increase physical fitness in f-ILDs, but the underlying mechanisms remain unclear.

Aims: To study the effects of exercise training on the different steps of oxygen transport in f-ILDs, particularly on lung diffusing capacity at rest and exercise.

Methods: Monocentric, prospective study from November 2023 to January 2025. Participants underwent a 12-week exercise training program (3 sessions per week). Assessments were conducted before and after the program, comprising diffusing capacity for carbon (DLCO) and nitric oxide (DLNO), at rest and steady-state cycling exercise (50% of $\dot{V}O_2$ reserve). They also performed CPET with oxygen uptake ($\dot{V}O_{2peak}$), cardiac (Physioflow®) and muscular (near infrared spectroscopy) monitoring.

Results: Forty-seven patients were included (mean age: 69.6 ± 8.5 years old, mean FVC: 76.1 : 17.4% of theoretical value, mean DLCO: $51.1 \pm 12.4\%$). Among included participants, 91% successfully completed dual DLCO-DLNO at exercise. At baseline, DLCO was more strongly correlated with lung capillary blood volume (V_c) ($r = 0.94$ at rest and $r = 0.91$ at exercise) than alveolar-capillary membrane conductance (D_m) ($r = 0.74$ at rest and $r = 0.52$ at exercise) (all $p < 0.001$). There was an increase in DLCO and D_m between rest and exercise (both $p < 0.001$), but no significant changes in V_c (29.7 ± 8.2 vs 31.3 ± 8.5 mL, $p = 0.2$).

Thirty-nine patients completed the 12-week training program. No significant changes between diffusing capacity components were found before and after exercise training. Among patients who increased $\dot{V}O_{2peak}$ ($n = 24$), alveolar ventilation (62 ± 16 vs 58 ± 16 L/min) and oxygen pulse (11.1 ± 2.6 vs 10 ± 2.2 mL/min/bpm) were greater after exercise training (both $p < 0.01$).

Conclusions: In our cohort of f-ILD patients, lung diffusing capacity at exercise appeared to be limited by the vascular component. Patients who increased their aerobic capacity with exercise training showed no further abilities to recruit lung capillaries, whereas better ventilation and cardiac function seemed to be the main determinants of their improvement.

Topic/s:Physiologie respiratoire
