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Inspiratory Muscle Training improves Oxygen Saturation and Hemoglobin Levels in Patients with Fontan Circulation – Results from a Randomized Home-Based Training Study

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Introduction
Pulmonary blood flow in patients with Fontan surgery is mainly driven by left heart suction forces and negative intrathoracic pressures during inspiration. Many patients suffer from decreased oxygen saturation (SpO_2) due to inhomogeneous lung perfusion or venovenous fistulae. Lower SpO_2 leads to elevated hemoglobin (Hb) levels for compensation. This study investigated, whether a daily, home-based inspiratory muscle training (InMT) can influence SpO_2, Hb and peak oxygen uptake (VO_2peak) in adult patients with Fontan circulation.

Methods
39 patients (female: 46%; 30.6 ± 8.2 years; BMI: 23.5 ± 4.4) with Fontan circulation were randomized into either an intervention (IG) or control group (CG). The IG (n=18) performed a telephone-supervised, daily InMT of 3 sets with 10-30 repetitions for six months with an inspiratory resistive training device (POWERbreathe). Patients randomized into CG (n=21) continued their usual activities. At baseline and final evaluation Hb was determined from peripheral venous blood and SpO_2 was captured by pulse oximetry at rest and during a cardiopulmonary exercise test (CPET). Data from the IG was compared to the data from the CG with a Wilcoxon rank sum test. All values are displayed in median and interquartile [IQR 25; 75].

Results
After six months of InMT, SpO_2 at rest increased in the IG in comparison to a slight decrease in the CG (delta SpO_2 at rest: IG: 1.50 [-0.25; 3.00] % vs. CG: -0.50 [-1.75; 0.75] %; p=.017). Hb level decreased in the IG compared to an increase in the CG (delta Hb: IG: -0.20 [-0.90; 0.20] g/dl vs. CG: 0.40 [-0.25; 0.80] g/dl; p=.040). There was no difference in VO_2peak and SpO2 at peak exercise between both groups (delta VO_2peak: IG: 0.05 [-1.53; 1.33] ml/kg/min vs. CG: -0.50 [-1.20; 0.78] ml/kg/min; p=.784; delta SpO_2 at peak exercise: IG: 1.00 [-2.00; 3.00] % vs. CG: -0.50 [-2.00; 2.00] %; p=.517).

Conclusions
Six months of a telephone-supervised, daily InMT do not affect exercise capacity in patients with Fontan circulation, but improve oxygen saturation at rest and consecutively reduces the primarily elevated hemoglobin level.