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Effects of High- and Low-Intensity Inspiratory Muscle Training Added to Inpatient Exercise-Based Cardiac Rehabilitation: A Preliminary Randomized Study

Ana Brajdić Šćulac[1]*, Kristina Skroče[1], Viktor Ivaniš[1], Dijana Travica Samsa[1,2], Snježana Ljubojević[1], Viktor Peršić[1,2]

[1]Thalassoterapia Opatija - Special Hospital for Medical Rehabilitation of Heart, Lung and Rheumatic Diseases, Opatija, Croatia
[2]University of Rijeka, Faculty of Medicine, Rijeka, Croatia

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***ADDRESS FOR CORRESPONDENCE:** Ana Brajdić Šćulac, Thalassotherapia Opatija, Maršala Tita 188/1, HR-51410 Opatija, Croatia. / Phone: +385-99-4212-237 / E-mail: ana.brajdic@yahoo.com

ORCID: Ana Brajdić Šćulac, https://orcid.org/0009-0005-1968-8954 • Kristina Skroče, https://orcid.org/0000-0003-0379-5235 Viktor Ivaniš, https://orcid.org/0000-0003-3349-0395 • Dijana Travica Samsa, https://orcid.org/0000-0001-6238-3738 Snježana Ljubojević, https://orcid.org/0009-0005-3743-5555 • Viktor Peršić, https://orcid.org/0000-0003-4473-5431

Introduction: Exercise-based cardiac rehabilitation (EBCR) improves exercise capacity, prognosis, and quality of life in patients with cardiovascular disease[1]. However, dyspnea and inspiratory muscle weakness may reduce exercise tolerance and limit rehabilitation benefits[2]. Inspiratory muscle training (IMT) may enhance EBCR outcomes, but the optimal training intensity and modality remain unclear.

Patients and Methods: This preliminary randomized study included 23 patients undergoing a three-week inpatient EBCR program. Participants were allocated to high-intensity interval IMT (HI IMT; n = 13) or low-intensity continuous IMT (LI IMT; n = 10). Both groups completed the same individualized, intensity-based EBCR program, including cycling, walking, and strength training; the additional IMT protocol was the sole between-group difference. Maximal inspiratory pressure (PImax), inspiratory muscle endurance (Tlim), cardiopulmonary exercise testing (CPET), six-minute walk test (6MWT), pulmonary function, echocardiographic parameters, and cardiac biomarkers were assessed before rehabilitation (T1) and after rehabilitation (T2). Time-related and between-group changes were analysed using two-way mixed analysis of variance (Time × Group). Paired Student's t-tests were used for within-group comparisons, with Wilcoxon signed-rank tests as complementary analyses. Statistical significance was defined as unadjusted $p < 0.05$.

Results: In the overall sample, PImax increased from 90.48 to 111.22 cmH_2O, corresponding to a mean improvement of 20.74 cmH_2O. Inspiratory muscle endurance increased from 170.7 to 347.3 seconds, a mean increase of 176.6 seconds; both changes were significant ($p < 0.001$). Relative peak oxygen uptake increased from 17.76 to 20.34 mL/kg/min, representing a 14.5% improvement. Peak power output increased by 17.5 W and 6MWT distance by 63.3 m (both $p < 0.001$). Left ventricular ejection fraction increased from 35.6% to 39.1% ($p < 0.001$). Both HI IMT and LI IMT groups showed significant improvements in PImax, VO_2peak, functional exercise capacity, and echocardiographic measures, without significant between-group differences for these outcomes. However, LI IMT produced greater improvement in inspiratory muscle endurance than HI IMT (+262.7 versus +110.3 seconds; Time × Group interaction $F(1,21) = 9.543$, $p = 0.006$, partial $\eta^2 = 0.312$).

Conclusion: Three weeks of inpatient EBCR combined with either HI IMT or LI IMT was associated with meaningful improvements in inspiratory muscle strength, aerobic capacity, functional performance, and cardiac function. LI IMT was associated with superior improvement in inspiratory muscle endurance, suggesting potentially different respiratory muscle adaptations. These exploratory results support incorporation of IMT into EBCR and warrant confirmation in a larger randomized trial.

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LITERATURE

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