

Editorial



Exercise Training in Patients With Fontan Circulation: Moving Towards Evidence-Based Rehabilitation

Se Yong Jung  MD, PhD, FACC, FESC

Division of Pediatric Cardiology, Severance Cardiovascular Hospital, Yonsei University College of Medicine, Seoul, Korea

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Correspondence to

Se Yong Jung, MD, PhD, FACC, FESC

Division of Pediatric Cardiology, Severance Cardiovascular Hospital, Yonsei University College of Medicine, 50-1, Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.
Email: jung81111@yuhs.ac

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ORCID IDs

Se Yong Jung 

<https://orcid.org/0000-0003-1337-563X>

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Over the past few decades, the Fontan operation has transformed the natural history of single-ventricle physiology from a fatal neonatal condition to a survivable chronic disease. However, despite the success of surgical palliation, patients with Fontan circulation continue to experience significant long-term morbidities, including diminished exercise capacity, which directly correlates with the prognosis and quality of life.^{1,2)}

In this issue of the *Korean Circulation Journal*, Choi et al.³⁾ present a timely and comprehensive systematic review and meta-analysis evaluating the effects of exercise training in patients with Fontan circulation. Through a rigorous analysis of 20 studies—including randomized controlled trials and cohort studies—the authors provide robust evidence that structured exercise training, particularly aerobic exercise initiated at a younger age, significantly improves peak oxygen consumption (VO_2) in this unique patient population.

A notable strength of this meta-analysis is the careful subgroup analysis based on age and exercise modality. The finding that exercise-induced improvements in VO_2 are more pronounced in children and adolescents than in adults underscores the importance of early intervention.³⁾ Moreover, the most pronounced benefits were seen with aerobic exercise, whereas resistance training and inspiratory muscle training did not yield statistically significant improvements in peak VO_2 . These findings align with those of previous systematic reviews in pediatric populations⁴⁾ and adult cohorts,⁵⁾ offering valuable guidance for clinicians aiming to implement tailored exercise rehabilitation programs for patients with Fontan circulation.

Nevertheless, this study highlights persistent gaps in the field. Although exercise capacity improved, ventilatory efficiency (minute ventilation/carbon dioxide production slope) did not show significant changes. This suggests that exercise alone may not fully address the cardiopulmonary challenges of Fontan physiology.³⁾ Additionally, the heterogeneity of exercise protocols and small sample sizes in several included studies underscore the need for larger, well-designed randomized trials to establish optimal exercise prescriptions with regard to intensity, duration, and combinations of training modalities.^{5,6)} Future research should consider multicenter collaboration to overcome sample size limitations and explore stratified approaches to individualized training. Incorporating advanced cardiopulmonary

Data Sharing Statement

The data generated in this study is available from the corresponding author upon reasonable request.

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testing and longitudinal outcome tracking will also be critical to better understand the physiological mechanisms underlying exercise responsiveness in this population.

Importantly, the authors emphasize the need for safe, supervised, and individualized exercise programs, particularly in pediatric patients, where overprotection and clinical concerns often limit physical activity.⁷⁾ In clinical practice, structured exercise implementation faces real-world barriers such as parental apprehension, lack of specialized pediatric cardiac rehabilitation programs, and resource constraints. Overcoming these challenges will require targeted education for families, training for providers, and potentially policy-level initiatives to support integrated cardiac rehabilitation services for congenital heart disease. Given the growing population of individuals with Fontan circulation and the increasing recognition of exercise capacity as a modifiable prognostic factor,¹⁾²⁾⁵⁾ this meta-analysis provides compelling evidence to support the routine integration of structured exercise rehabilitation into long-term Fontan care.

In conclusion, the systematic review by Choi et al.³⁾ advances the field by reinforcing the role of exercise as a safe and effective strategy for improving the functional capacity in patients with Fontan circulation. Their work underscores that early, structured, and aerobics-focused rehabilitation is not just beneficial but essential in the continuum of care for this vulnerable population. Future research focused on individualized, multicenter exercise interventions will be critical to refining these recommendations and translating them into standardized clinical practice.⁸⁾

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