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CASE REPORT
Heart failure

Atrial fibrillation in heart failure with reduced ejection fraction: a case report of exercise training

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Background Heart failure (HF) and atrial fibrillation (AF) are often concomitant and act in a vicious cycle. Atrial fibrillation is associated with greater functional limitations and increased morbidity and mortality in patients with HF. Moreover, AF associated with HF increases patients' physical inactivity, worsening their clinical condition, and prognosis. Exercise training is safe and has clear benefits in HF. However, these benefits have not been demonstrated when AF is associated with HF.

Case summary We present the case of a 57-year-old man with permanent AF and HF with reduced ejection fraction, who underwent 12 weeks of exercise training that included cardiopulmonary exercise testing, neuromuscular sympathetic activity (NMSA), and muscle blood flow (MBF) before and after training.

Discussion Exercise training was shown to have a potential benefit in reducing the activity of the sympathetic nerve and increasing muscle blood flow, as well as increasing VO_{2peak} and decreasing the VE/VCO_2 slope in a patient with AF associated with HF with reduced ejection fraction. These results may indicate favourable clinical implications in this group of patients.

Keywords Exercise training • Heart failure • Atrial fibrillation • Muscular blood flow • Neuromuscular sympathetic activity • Case report

Learning points

- Exercise training increases cardiopulmonary performance improving muscle blood flow. It should be recommended to patients with atrial fibrillation associated with heart failure.
- The increased sensitivity of the arterial baroreflex re-establishing control over sympathetic activity, leading to improved muscle flow and exercise capacity.
- These results may indicate favourable clinical implications in this group of patients.

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Introduction

Heart failure (HF) and atrial fibrillation (AF) are often concurrent clinical conditions, and they may be the cause or consequence of each other, progressing in a vicious cycle.[1] Approximately 40% of patients with HF present AF, leading to greater functional impairment and increased morbidity and mortality.[2] Restoration and maintenance of sinus rhythm is challenging in these patients, with a low long-term success rate of cardioversion and ablation in patients with AF and HF.[1,2]

Regular physical activity is an evidence-based adjuvant therapy for HF. Exercise training attenuates the activity of the sympathetic nervous system and improves functional capacity, leading to lower rates of hospitalization and better quality of life.[3–5] However, studies evaluating the effects of exercise in patients with HF and AF are lacking.

Physical inactivity may worsen the exercise intolerance in patients with AF and HF, aggravating the clinical condition, increasing the risk of hospitalization, and worsening quality of life.[1,2] Physical activity can help break the vicious cycle of low functional capacity resulting from the binary AF and HF and should be recommended to these patients, as long as they are clinically stable, with optimized clinical treatment according to guidelines, with a resting heart rate ≤80 b.p.m. and ≤110% of the predicted for their maximum exercise age.[6]

This case report shows the changes on physical capacity, neuromuscular sympathetic activity (NMSA), and muscular blood flow (MBF) after a supervised exercise training guided by the Borg scale in a patient with AF associated with HF and reduced left ventricular ejection fraction (LVEF).

Timeline

Time	Events
Routine medical consultation	• New York Heart Association III • Clinically stable • Drug therapy optimized • Referred for exercise training
Before to supervised exercise training (SET)	• Cardiopulmonary exercise test • Sympathetic nerve activity • Muscle blood flow
SET for a period of 12 weeks	• 5 min of warm-up exercises • 30 min of aerobic training (intensity 11–13 Borg scale) • 20 min of resistance exercises • 5 min of relaxation exercises • No adverse events
After 12 weeks of SET	• Cardiopulmonary exercise test • Sympathetic nerve activity • Muscle blood flow
Results of SET	• Increased VO_{2peak} • Decreased VE/VCO_2 slope • Reduced sympathetic activity • Improved muscle flow

Case presentation

A 57-year-old Caucasian man diagnosed with HF due to hypertensive dilated cardiomyopathy associated with permanent AF was referred to an exercise training program. He had non-insulin-dependent diabetes mellitus and LVEF was 35%. The functional class was III [(New York Heart Association (NYHA)] and drug therapy was according to the III Brazilian Guideline on Heart Failure and II Brazilian Guideline on Atrial Fibrillation: Losartan 100 mg, Furosemide 40 mg, Carvedilol 150 mg, Warfarin 5 mg, Simvastatin 20 mg, Metformin 1700 mg, and Omeprazole 20 mg. Because of a long history of AF, rate control strategy was implemented. The patient did not have a history of neuromuscular or pulmonary disease. He never smoke and did not drink alcohol. According to his level of physical activity, he led a sedentary life, defined as self-reported less than 1 day/week of planned, structured, and repetitive exercise. His body mass index was 36.8 kg/m^2 and resting blood pressure was 115/80 mmHg. Resting electrocardiogram showed AF with an average heart rate of 75 b.p.m.

The supervised exercise training program was carried out three times a week, for a period of 12 weeks in a closed environment, with a controlled temperature between 21°C and 24°C in the afternoon (3:30 pm to 4:30 pm). The exercise training protocol consisted of 5 min of warm-up exercises, 30 min of aerobic training performed on a cycle ergometer at 60 rpm, 20 min of resistance exercises with lower and upper limbs and 5 min of relaxation exercises. The workload was adjusted during the stimulus phase of the aerobic training to keep the perceived effort intensity between 11 (relatively easy) and 13 (slightly tiring) of the Borg Scale.[7] Resistance training was performed in a weight training station and consisted of 2 sets of 10 repetitions, and the following sequence of exercises: leg extension, leg curl, lat pull-down, peck deck, and press chest. The initial workload was set at 60% of 1 repetition maximum.[8] He was encouraged to complete the sets of 10 prescribed repetitions, performing the appropriate movement and avoiding Valsalva manoeuvre. He was instructed to rest for 30–60 s between sets. The intensity of the exercise was increased from 5% to 10% whenever the patient adapted to the exercise workload thorough the 12 weeks of training.

After 12 weeks of supervised sessions, the patient became asymptomatic (NYHA I) and was instructed to continue exercising at home.

Table 1 displays the results of the cardiopulmonary exercise test before and after 12 weeks of exercise training, performed on a cycle ergometer, using the modified Balke protocol (25 w/min).[4] Comparing the exercise test before and after 12 weeks, we observed that the rest HR reduced and the peak HR increased, and that systolic blood pressure increased, and diastolic blood pressure decreased at the peak of exercise. Peak oxygen consumption (VO_{2peak}) increased and VE/VCO_2 slope decreased after training. *Figure 1* shows data on muscle sympathetic nerve activity (NMSA) before and after the intervention, obtained by a microelectrode implanted in the fibular nerve and recorded by the shots per minute and every 100 b.p.m.[6] We observed that the shots decreased in both registers, indicating a reduction in NMSA. The muscle blood flow (MBF), obtained by plethysmography venous occlusion,[6] increased after exercise intervention as shown in *Figure 2*.

Table 1 Cardiopulmonary exercise pre- and post-12 weeks of exercise training

	Pre	Post
Heart rate (b.p.m.)		
Resting	75	70
Maximum	111	116
Systolic blood pressure (mmHg)		
Resting	115	115
Maximum	130	135
Diastolic blood pressure (mmHg)		
Resting	80	75
Maximum	79	75
VO_{2peak} (mL/kg/min^{-1})	14.7	16.0
VE/VCO_2 slope	33	28
Tolerance (min)	7	10
RER (VCO_2/VO_2)	1.05	1.15

RER, respiratory exchange ratio; VO_{2peak}, peak oxygen consumption; VE/VCO_2 slope, the slope of the line between pulmonary ventilation (mL/min) and carbon dioxide production (mL/min).

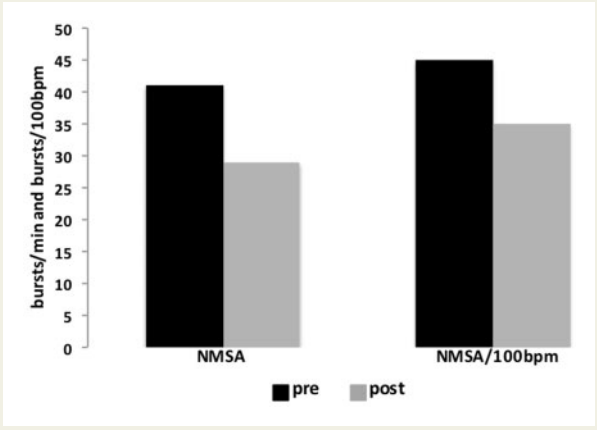

Figure 1 Muscle sympathetic nerve activity (NMSA) per minute and every 100 b.p.m. before and after the intervention.

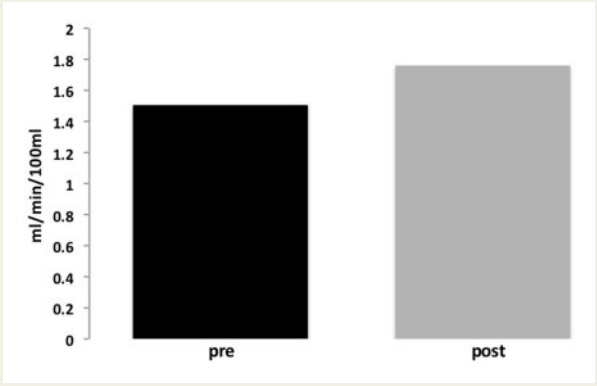

Figure 2 Muscle blood flow (MBS) before and after the intervention.

Discussion

This case study highlights the known benefits of physical exercise in heart failure with reduced ejection fraction and permanent atrial fibrillation. To the best of our knowledge, this is the first report of the benefits of exercise training guided by the Borg scale on physical capacity, neuromuscular sympathetic activity, and muscle blood flow in a patient with AF and HF with reduced ejection fraction.

Muscle sympathetic nerve activity is an independent predictor of prognosis in HF.[9] The reduction in the frequency of NMSA shots after exercise reinforces the idea that physical training contributes to improve prognosis in these patients. The present report shows a reduction in NMSA in AF associated with HF, but it does not elucidate its mechanisms. Nevertheless, it is reasonable to speculate that exercise training promotes increased sensitivity of the arterial baroreflex, restoring control of sympathetic nerve activity, and heart rate, which may be associated with improved sensitivity of the aortic depressor.[10,11] In addition, exercise training may have reduced peripheral chemoreflex sensitivity, improving the ergoreflex control of NMSA in AF associated with HF.[12]

Evidence shows that exercise training increases muscle blood flow in HF,[13] which was also observed in our report of a patient with AF associated with HF. This observation may have useful clinical implications because muscle blood flow is an independent predictor of mortality in HF.[9] The increase in muscle blood flow after exercise training may have resulted from better endothelial function, shifting the balance between vasodilation and vasoconstriction.[12]

The presence of AF is related to lower exercise capacity, which is associated with reduced VO_{2peak} and increased VE/VCO_2 slope.[14] The association of AF with HF has important clinical implications, with a higher risk of hospitalization and death.[13] Studies have shown that exercise training increases the VO_{2peak} and a decrease the VE/VCO_2 slope in patients with HF.[3,15] The findings of this case report are consistent with these studies, highlighting how the benefits of exercise training can be extended to patients with AF and HF, as long as they are clinically stable, with optimized drug therapy, using beta-blockers and with controlled heart rate at rest and exercise.

On the other hand, a sub-analysis of the HF-ACTION suggested a lack of efficacy of aerobic exercise in improving the prognosis of patients with HF and AF.[16] Nevertheless, the HF-ACTION study was not designed for patients with HF and AF, and the low compliance and different aspects of exercise protocol may have contributed to an only mild increase in VO_{2peak}. Also, the intensity of aerobic exercise using 60–70% of the heart rate reserve does not apply to patients with AF.[17,18]

Finally, although restoration of sinus rhythm may improve haemodynamics and prognosis in patients with HF and AF, as recent trials with catheter ablation have suggested, maintaining sinus rhythm is challenging in clinical practice and it needs to be compared with rate-control strategy in large double-blind clinical trials.[19,20] Importantly, despite this patient became asymptomatic, VO_{2peak} remained low, and his prognosis can be further improved by therapies that showed to improve survival in symptomatic patients with HFrEF, such as changing losartan to sacubitril/valsartan and adding spironolactone.[21]

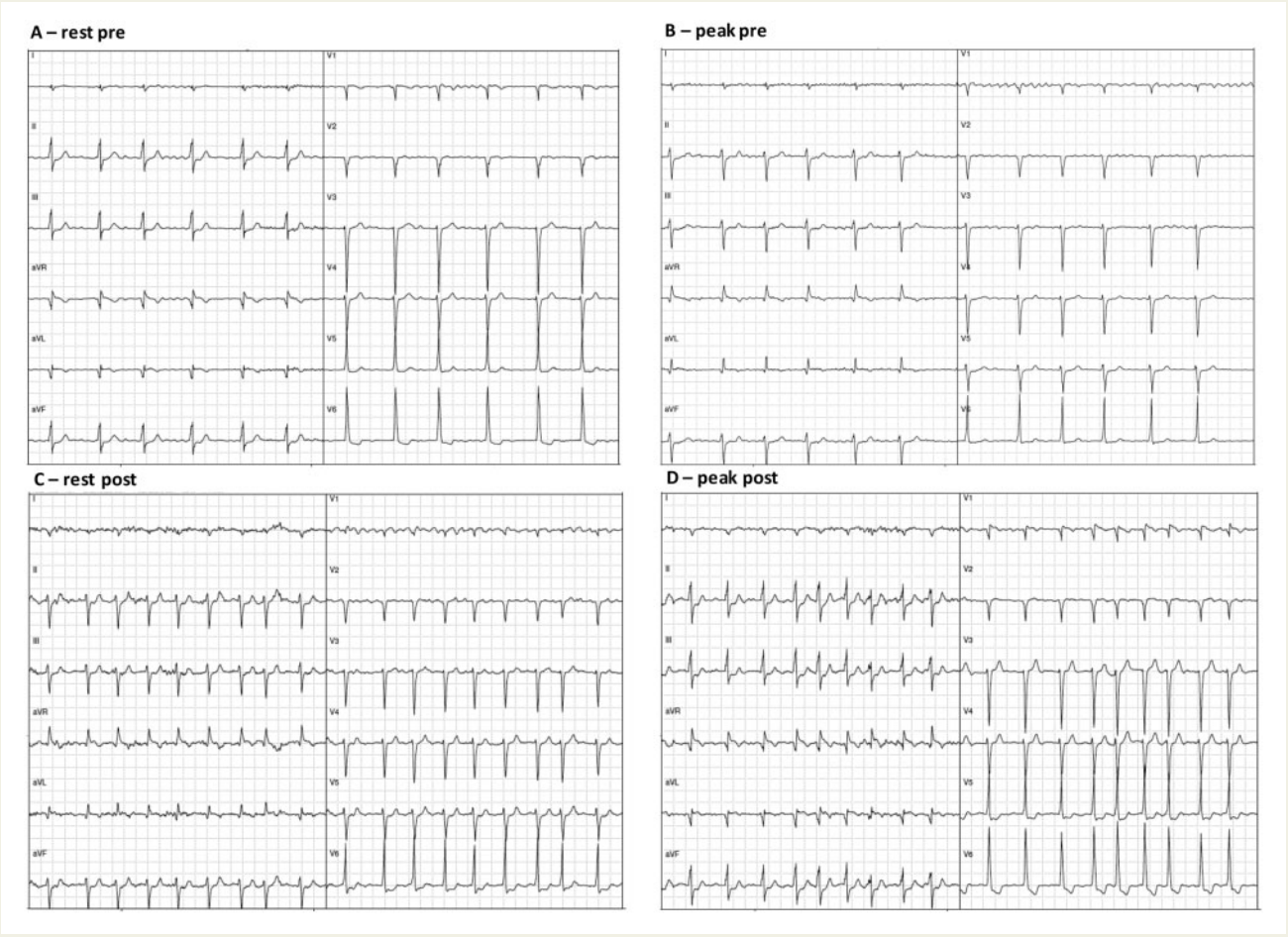

Figure 3 Electrocardiogram pre- and post-12 weeks of exercise training. (*A*) Pre-rest; (*B*) pre-peak; (*C*) post-rest, and (*D*) post-peak.

More recently, a sodium-glucose co-transporter-2 (SGLT2) inhibitor showed to improve survival in this population.[22]

Exercise training is key to improve functional capacity and quality of life, with low risk of side effects and complications, being an essential and safe tool for treating patients with HF. The present case showed that exercise using the Borg scale of perceived exertion to guide intensity can improve the tolerance to exercise, increase the MBF, decrease the resting HR, and increase maximum HR, which may be related to better balance in the autonomic nervous system.[23]

These favourable results must be confirmed by future studies and by the replication of research that examines the impact of exercise training in patients with AF and HF with both reduced and preserved ejection fraction. They should evaluate the effects on different outcomes, such as muscle sympathetic nerve activity, muscle blood flow, and functional capacity, and include other modalities of exercise, such as interval aerobic training, water-based exercises, inspiratory muscle training, and yoga. This will help better understand the role and potential mechanisms of exercise training in patients with HF and AF, and provide specific recommendations for this population.

Conclusion

Exercise training showed potential benefits in a patient with AF associated with HF with reduced ejection fraction, reducing sympathetic nerve activity, increasing muscle blood flow and the VO_{2peak}, and decreasing the VE/VCO_2 slope and resting heart rate.

Lead author biography

Guilherme Veiga Guimarães, Phd., Researcher, School of Medicine, University of São Paulo. He is currently a cardiac rehabilitation researcher at the Heart Institute of Hospital das Clínicas, University of São Paulo, with an interest in exercise physiology.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

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Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidelines.

Conflict of interest: none declared.

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