Gait pattern and muscle oxygen saturation changes act synergistically to improve exercise tolerance after multimodal training in patients with symptomatic lower extremity artery disease

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Topic(s):
Peripheral Vascular and Cerebrovascular Disease - Treatment

Citation:
European Heart Journal ( 2019 ) 40 ( Supplement ), 2908

Introduction: Patients with atherosclerotic lower extremity artery disease (LEAD) have impaired walking capacities leading to decreased quality of life. Previous studies showed that LEAD patients also have altered gait pattern (decrease speed, cadence and step length, and increased stance phase). Reduced strength and endurance of lower limb muscles play a major implication in these adaptations. Supervised exercise training (SET) is effective in improving walking performances in symptomatic LEAD patients. However, there is no clear consensus whether SET also influences gait pattern. The aim of the present study was to investigate the effects of SET on gait pattern and calf muscle oxygen saturation (StO2) changes.

Methods: Fontaine stage II LEAD's patients following a 3-month multimodal (Nordic walking and lower limbs strengthening) SET were investigated. Constant-load treadmill incline walking test (2.5–3.2 km/h at 12%) was used to determine pain-free walking distance (PFWD) and maximal walking distance (MWD). During the treadmill test, spatiotemporal parameters (Physilogs®, GaitUp, Switzerland) and calf StO2 (NIRS, PortaMon, Artinis, The Netherlands) were assessed at baseline, PFWD and MWD. Ankle-brachial Index (ABI) and toe-brachial index (TBI) were also measured. All assessments were performed prior and after SET.

Results: Twenty stage II LEAD patients (62.7±2.4 yr, 80% men, 75% stage IIa) were included. Following SET, PFWD (98.5±10.0 pre- vs. 177.0±31.7m post-SET; P=0.012), and MWD (396.0±62.6 pre- vs. 633.0±107.4m post-SET; P=0.01) significantly increased. ABI (0.85±0.05 pre- vs. 0.85±0.03 post-SET; P=0.96) and TBI (0.61±0.03 pre- vs. 0.65±0.04 post-SET; P=0.07) did not change significantly. Following SET, patients had significantly shorter stride duration (−3%, P=0.05), higher cadence (+3%, P=0.04), longer double support (+10%, P=0.04), shorter swing (−3%, P=0.03), and longer stance duration phase (+2%, P=0.03). In addition, after SET patients also had significantly longer duration of the loading response (+9%, P=0.04) and foot-flat (+3%, P=0.04), and shorter duration of the push-off phase (−8%, P=0.01). Stride length was shorter although not significant (−2%, P=0.13). After SET, delta StO2 (baseline=0) was greater at PFWD (+33%) and at MWD (+68%; P=0.05, with no significant interaction effect).

Conclusions: These results confirm beneficial effects of SET on walking performances. After SET, the prolonged duration of loading response and foot-flat (stance sub-phases associated with limited calf muscles activation) may be a strategy to increase calf muscles oxygenation. The observed greater calf muscle oxygen desaturation (increased oxygen extraction) after SET may be related to an improved microvascular milieu leading to a better match between muscle oxygen delivery and utilization during exercise. Taken together, gait pattern and muscle oxygen desaturation changes may act synergistically to improve exercise tolerance in patients with LEAD.