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ORIGINAL RESEARCH

Effects of Twice-Weekly Intense Aerobic Exercise in Early Subacute Stroke: A Randomized Controlled Trial

Klas Sandberg, MSc, RPT,[a,b] Marie Kleist, BSc, RPT,[a] Lars Falk, MD, PhD,[c,d,e] Paul Enthoven, RPT, PhD[c,f]

From the [a]Department of Rehabilitation and Department of Medical and Health Sciences, Linköping University, Norrköping; [b]Department of Internal Medicine, Vrinnevi Hospital, Norrköping; [c]Research and Development Unit of Local Health Care and Department of Medical and Health Sciences, Linköping University, Linköping; [d]Department of Dermatology and Venereology Linköping University, Linköping; [e]Department of Clinical and Experimental Medicine, Linköping University, Linköping; and [f]Department of Medical and Health Sciences, Linköping University, Linköping, Sweden.

Abstract

Objective: To examine the effects of 12 weeks of twice-weekly intensive aerobic exercise on physical function and quality of life after subacute stroke.

Design: Randomized controlled trial.

Setting: Ambulatory care.

Participants: Patients (N = 56; 28 women) aged ≥50 years who had a mild stroke (98% ischemic) and were discharged to independent living and enrolled 20 days (median) after stroke onset.

Interventions: Sixty minutes of group aerobic exercise, including 2 sets of 8 minutes of exercise with intensity up to exertion level 14 or 15 of 20 on the Borg rating of perceived exertion scale, twice weekly for 12 weeks (n = 29). The nonintervention group (n = 27) received no organized rehabilitation or scheduled physical exercise.

Main Outcome Measures: Primary outcome measures included aerobic capacity on the standard ergometer exercise stress test (peak work rate) and walking distance on the 6-minute walk test (6MWT). Secondary outcome measures included maximum walking speed for 10m, balance on the timed Up and Go (TUG) test and single leg stance (SLS), health-related quality of life on the European Quality of Life Scale (EQ-5D), and participation and recovery after stroke on the Stroke Impact Scale (SIS) version 2.0 domains 8 and 9. Participants were evaluated pre- and postintervention. Patient-reported measures were also evaluated at 6-month follow-up.

Results: The following improved significantly more in the intervention group (pre- to postintervention): peak work rate (group × time interaction, $P = .006$), 6MWT ($P = .011$), maximum walking speed for 10m ($P < .001$), TUG test ($P < .001$), SLS right and left (eyes open) ($P < .001$ and $P = .022$, respectively), and SLS right (eyes closed) ($P = .019$). Aerobic exercise was associated with improved EQ-5D scores (visual analog scale, $P = .008$) and perceived recovery (SIS domain 9, $P = .002$). These patient-reported improvements persisted at 6-month follow-up.

Conclusions: Intensive aerobic exercise twice weekly early in subacute mild stroke improved aerobic capacity, walking, balance, health-related quality of life, and patient-reported recovery.

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The decrease in aerobic capacity after stroke continues during the subsequent 6 months and often remains decreased thereafter. Most patients do not spontaneously recover to the aerobic levels of comparable healthy subjects.[1-4] The maximum oxygen uptake is reduced to 10 to 17mL/kg/min in the 0 to 30 days after stroke[1-3] and does not increase to >20mL/kg/min after 6 months[2]; this is 25% to 45% lower than the maximum oxygen uptake in age-matched, healthy persons without stroke.[2] This reduction in maximum oxygen uptake might affect rehabilitation of patients with stroke who have a greater need for aerobic capacity for walking and performing activities of daily living.[5] An early start to aerobic exercise to prevent reduced aerobic capacity could improve rehabilitation after stroke.

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Aerobic exercise has a beneficial effect in chronic stroke.[6-8] A systematic review showed beneficial effects even during subacute stages (ie, 7d to 6mo after stroke), with improvements in peak oxygen uptake and walking distance.[9] However, the results on walking speed and balance were unclear or conflicting, and the outcome on quality of life was also not explored. There is a lack of exercise prescription, and the range of possible benefits is not fully explored.[9-11]

Walking and balance are important functions to recover after stroke.[12] Functional limitations frequently necessitate ongoing rehabilitation.[13] Reduced aerobic capacity and muscle weakness impede participation in everyday physical and social activities, and impaired social communication ability further reduces quality of life.[14] Patients with stroke report a lower quality of life than healthy individuals.[15]

According to the Swedish Stroke Register, only 15% of patients with mild to moderate stroke receive further rehabilitation after their discharge to independent living.[16] At the stroke clinic of the present study, patients with mild stroke were usually discharged to independent living without further rehabilitation. All patients had a follow-up visit by their physician 3 months after discharge.

The primary aim of the present randomized controlled trial was to determine whether 12 weeks of twice-weekly intensive aerobic exercise in the subacute phase after mild stroke improved aerobic capacity and walking distance. The secondary aims were to study the effects of this exercise program on walking speed, functional mobility, and balance and on health-related quality of life (HRQOL) and social participation.

Methods

This study was a single-center, parallel randomized prospective controlled trial. The study was guided by the Consolidated Standards of Reporting Trials statement. The study was approved by the Regional Ethics Committee, Linköping, Sweden.

Participants

Patients were recruited from the stroke unit at Vrinnevi Hospital, Norrköping, Sweden, during 2011 to 2013. Written informed consent was obtained from the enrolled subjects. The subjects were ≥50 years old, and there was no upper age limit. There was a structured rehabilitation program for those <50 years old, and their rehabilitation was carried out in another clinic. All subjects had a stroke that was diagnosed by a physician within 3 days prior to the request for inclusion. Subjects had to be able to walk >5m with or without support and to understand spoken and written instructions. Their impairments corresponded to mild stroke (National Institutes of Health Stroke Scale score <6).[17,18]

List of abbreviations:

EQ-5D	**European Quality of Life Scale**
HRQOL	**health-related quality of life**
RPE	**rating of perceived exertion**
SIS	**Stroke Impact Scale**
SLS	**single leg stance**
6MWT	**6-minute walk test**
TUG	**timed Up and Go**
VAS	**visual analog scale**

Exclusion criteria were medical or neurologic diseases that could either be a risk or make the training program difficult to fulfill. This judgment was made by the treating physician.

Procedures

At the start of the study (preintervention) and prior to randomization, aerobic capacity was measured using a standard exercise stress test in the department of clinical physiology by unbiased investigators blinded to the randomization outcome. Other physical assessments (subsequently listed) were carried out in the stroke unit. The assessments were repeated after 3 months (postintervention).

At preintervention, all patients received a questionnaire about HRQOL, social participation, and their sense of recovery. Patients filled out the questionnaires at home and were asked to send them back to the clinic within 2 weeks. The second questionnaire was sent to the participants 1 week before the postintervention assessment. The third questionnaire was sent 6 months after the start of the study (follow-up). The intervention started within 3 days after randomization. Randomization was performed by shuffling concealed envelopes that were then picked randomly.

Intervention

The American Heart Association recommends 20- to 60-minute sessions of aerobic exercise of training 3 to 7 days per week after stroke.[19] The intensity should be 50% to 80% of the maximal heart rate (11−14 on the Borg rating of perceived exertion [RPE] scale).[19,20] After discharge to independent living, the intervention group began a 12-week training period that included twice-weekly 60-minute aerobic exercise sessions. The sessions were conducted at the hospital and included a maximum of 10 participants. New patients were included consecutively and continuously (ie, each patient exercised according to his or her ability). The exercise sessions were led by an experienced physiotherapist (M.K. or K.S.) or by both if the group had >6 patients. Music was used to guide the exercise intensity using different numbers of beats per minute. The individual exercise intensity was adapted during each session by adjusting the load or the cycling speed so that the exercise goals were achieved. If the patients did not spontaneously reach the target intensity, they were given verbal encouragement. During exercise weeks 1, 6, and 9, the participants carried heart rate monitors[a] to help them achieve an exercise intensity that was within the prescribed target heart rate range. The monitors also made the participants aware of the degree of effort that was required to reach the target range. Attendance at exercise sessions was recorded in the exercise log.

Aerobic exercise program

Each 60-minute session had 5 parts: (1) a 15-minute warm-up that included sitting, standing, and walking; (2) 8 minutes of high-intensity aerobic exercise on an ergometer cycle; (3) 10 minutes of lower-intensity mixed exercises that were intended to increase the flexibility of large muscle groups while sitting, standing, and walking; (4) 8 minutes of high-intensity aerobic exercise on an ergometer cycle; and (5) a 15-minute cool-down in different positions.

We calculated that it should take a total of 4 minutes to move between exercise stations during the session.