Supervised and home-based exercise training for patients with intermittent claudication

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Peripheral arterial disease is an atherosclerotic disease that mostly affects older populations (1,2). A study in Australia (3) reported that the prevalence of the disease was 10.6% in men 65 to 69 years of age and 23.3% in men 75 to 79 years of age. This prevalence is expected to rise as our society ages. Intermittent claudication (IC) is the most common symptom of peripheral arterial disease (4). It is a severe muscular pain that presents while walking, usually in the calf muscle. This symptom seriously limits walking capacity (5) and reduces the quality of life (6) of patients.

Exercise training was demonstrated to be an effective treatment that improves the walking capacity of patients with IC (5,7). Supervised programs usually increase patients’ walking capacity following 12 to 24 weeks of training (8-14), while the evidence on the effectiveness of home-based programs, when applied as the primary treatment, is equivocal (15-17). However, supervised programs are costly, and it is not always feasible for elderly patients to travel to rehabilitation centres. Therefore, it is important to develop an effective way for patients to apply home-based exercise programs.

The present study examined whether a home-based exercise program, applied as the primary treatment in patients with intermittent claudication, had produced inconsistent effects on walking capacity in previous published studies. The aim of the present study was to evaluate whether a home-based exercise training program could maintain improved walking capacity and other functional variables achieved through a supervised exercise training program. The present design was a 48-week self-controlled study. The first 12-week period was a control stage in which no prescribed exercise program was provided, the second 12-week period was a supervised treadmill-walking training program and the following 24-week period was a home-based exercise program. Twenty-two subjects with intermittent claudication were recruited initially; 15 of them (14 men and one woman) completed the whole program. Walking capacity, peak oxygen uptake, walking economy and ankle-brachial index were measured at baseline and at 12, 24 and 48 weeks. There was no significant change in the measured variables after the control stage. The 12-week supervised treadmill-walking training program significantly increased pain-free walking time, maximal walking time and peak oxygen uptake. Walking economy was also significantly improved. These improvements were successfully maintained after 24 weeks of home-based training. The results indicated that 12 weeks of supervised treadmill-walking training followed by a home-based training program is an effective model of exercise rehabilitation for patients with intermittent claudication.

Key Words: Functional capacity; Home-based exercise training; Peripheral arterial disease

Study design
The present 48-week investigation consisted of three stages. The first 12-week period was a control stage with no prescribed exercise program, the second 12-week period was a supervised treadmill-walking training program and the following 24-week period was a home-based exercise program. Walking capacity, peak oxygen uptake (VO₂), walking economy (WE) and ankle-brachial systolic blood pressure index (ABI) were measured at baseline and at 12, 24 and 48 weeks.

Subjects
Volunteer subjects were recruited from the local population of the Northern Rivers region of New South Wales, Australia. The selection criteria included: age between 50 and 80 years, resting ABI below 0.90 that decreased to below 0.80 after a treadmill test, and a stable history of IC for at least six months. The following conditions excluded participation: resting ischemic pain, ulceration or gangrene in the legs; inability to walk on the treadmill at a speed of 3.2 km/h; and exercise capacity limited by symptoms of angina, congestive heart failure, chronic obstructive pulmonary disease or arthritis. The present study was approved by the Human Research Ethics Committee of Southern Cross University, Australia. Informed consent was obtained from each subject.

Measurements
With the subject in a supine position, systolic blood pressure was measured at the brachium and ankle using a bidirectional...
Table 1

Walking capacity, peak oxygen uptake (VO₂), walking economy and ankle-brachial index throughout the study period

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>12 weeks</th>
<th>24 weeks</th>
<th>48 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain-free walking</td>
<td>120±63</td>
<td>143±73</td>
<td>395±277*</td>
<td>377±258†</td>
</tr>
<tr>
<td>Maximal walking</td>
<td>299±115</td>
<td>331±138</td>
<td>722±186*</td>
<td>675±175‡</td>
</tr>
<tr>
<td>Maximal time, s</td>
<td>13.29±2.20</td>
<td>12.95±2.20</td>
<td>14.78±2.79‡</td>
<td>14.40±1.74</td>
</tr>
<tr>
<td>Walking economy, mL/kg/min</td>
<td>11.97±2.15</td>
<td>11.50±1.96</td>
<td>9.60±0.97</td>
<td>9.97±1.49†</td>
</tr>
<tr>
<td>Ankle-brachial index</td>
<td>0.61±0.22</td>
<td>0.64±0.17</td>
<td>0.67±0.19</td>
<td>0.65±0.18</td>
</tr>
</tbody>
</table>

All data are presented as mean ± SD. *P<0.01; †P<0.001, 48-week test versus baseline test; ‡P<0.01; †P<0.001, 24-week test versus 12-week test.

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Supervised exercise training program

An individual treadmill-walking training program was prescribed according to the outcomes of the 12-week test. Subjects trained in the laboratory for 1 h per session, at three sessions per week for 12 weeks. Each subject started walking at 3.2 km/h with an individualized incline. This combination elicited moderate claudication (level 4 on the five-point scale) after approximately 5 min of walking. Subjects stopped and rested in a sitting position when they felt moderate claudication. They resumed when the pain resolved. Each time the subject could walk for 7 min interval without moderate claudication, the treadmill incline was increased by 0.5%, until it reached 5%. The walking intensity was further augmented by increasing treadmill speed by 0.5 km/h each time. The progressive increase of exercise intensity aimed to provide continuous overloading to improve walking capacity while training. All training sessions were supervised by the researcher; an electrocardiogram (modified lead II configuration) was monitored when exercise intensity was increased.

DISCUSSION

The main finding of the present study was that the 12-week supervised treadmill-walking training program significantly increased the walking capacity of this group of subjects. More importantly, the 24-week home-based exercise program successfully maintained this improvement. The walking capacity, peak VO₂ and WE were maintained at better levels than the baseline values.
Claudication and exercise

There has been a report in the literature (17) that home-based exercise programs maintained the effects of training on maximal walking distance achieved through 12 weeks of supervised exercise training in patients with IC. Another study (21) noted that the improved walking capacity after exercise training would deteriorate within six months if the subjects did not continue to exercise regularly. The present findings support regular exercise to maintain beneficial training effects in patients, even with minimal supervision.

Home-based exercise programs have been used as a primary intervention in patients with IC; however, the outcomes have been inconsistent. One study (16) compared the effects of a hospital-based exercise program with a home-based exercise program and reported that the home-based training did not improve walking capacity or peak oxygen consumption. The authors indicated that individual motivation and self-administered exercise intensity may be the two major factors contributing to the noneffectiveness of the home-based exercise program. In contrast with higher levels of supervision that included weekly educational lectures and telephone reviews, other studies reported that home-based exercise programs significantly increased PFWT (17), as well as MWT or mean walking distance (15,17).

Unlike the uncertain outcomes of home-based exercise programs, 12 to 24 weeks of supervised exercise training has shown definitive benefits in walking capacity (9,11,22). However, supervised exercise programs need a higher level of commitment from the patients, and sophisticated equipment such as treadmills and electrocardiogram monitors. From the long-term social and economic viewpoint, a less structured, home-based exercise program would be more practical for the patients.

The present study demonstrated an effective use of supervised and home-based exercise for the subjects—a short-term supervised exercise training program combined with a long-term home-based exercise program. In this way, the basic skills of walking intensity control, warm-up and cool-down activities were introduced and practised during the supervised exercise training. The successful maintenance of improved functional capacity was attributable to the educational role of the supervised exercise training. In addition, monitoring the training progression with regular telephone calls from the researcher may have also played an important role in ensuring adherence to the exercise program and the quality of training. As a result, the subjects can enjoy higher functional capacity for a longer time through a self-administered home-based exercise program.

The results of the constant-load treadmill test also showed a satisfactory outcome. At 48 weeks, most subjects in the present study could walk longer than 10 min, which corresponded to 500 m. This capacity enabled the subjects to walk from the car park to targets (shop, post office, medical centre, etc) in their daily life. With the increased mobility and independence, the quality of life would be enhanced significantly as a result of this exercise program.

The results concerning resting and postexercise ABI from the present study agreed with previously reported research (9,11,19). Although there was a significant increase in walking capacity, the ABI did not show any significant change following exercise training. As indicated in a review (23), the ABI has been thought of as a reflection of the changes in systolic blood pressure in the arteries; it may not correlate with the blood supply to active muscles during walking.

CONCLUSION

The present study demonstrated that when subjects were monitored regularly and educated on how to exercise, their improved walking capacity, which was achieved through a supervised exercise training program, was well maintained through a home-based exercise program, with minimum cost and supervision. Therefore, we report that supervised training for 12 weeks followed by home-based exercise is an effective model of exercise therapy for patients with IC.

REFERENCES

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