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Original article

Nordic walking versus walking without poles for rehabilitation with cardiovascular disease: Randomized controlled trial

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ABSTRACT

Background: With Nordic walking, or walking with poles, one can travel a greater distance and at a higher rate than with walking without poles, but whether the activity is beneficial for patients with cardiovascular disease is unknown.
Objective: This randomized controlled trial was undertaken to determine whether Nordic walking was more effective than walking without poles on walk distance to support rehabilitation training for patients with acute coronary syndrome (ACS) and peripheral arterial occlusive disease (PAOD).
Methods: Patients were recruited in a private specialized rehabilitation centre for cardiovascular diseases. The entire protocol, including patient recruitment, took place over 2 months, from September to October 2013. We divided patients into 2 groups: Nordic Walking Group (NWG, $n = 21$) and Walking Group without poles (WG, $n = 21$). All patients followed the same program over 4 weeks, except for the walk performed with or without poles. The main outcome was walk distance on the 6-min walk test. Secondary outcomes were maximum heart rate during exercise and walk distance and power output on a treadmill stress test.
Results: We included 42 patients (35 men; mean age 57.2 ± 11 years and BMI 26.5 ± 4.5 kg/m^2). At the end of the training period, both groups showed improved walk distance on the 6-min walk test and treatment stress test as well as power on the treadmill stress test ($P < 0.05$). The NWG showed significantly greater walk distance than the WG ($P < 0.05$). Both ACS and PAOD groups showed improvement, but improvement was significant for only PAOD patients.
Conclusions: After a 4-week training period, Nordic walking training appeared more efficient than training without poles for increasing walk distance on the 6-min walk test for patients with ACS and PAOD.

1. Introduction

Aerobic physical training is effective in the care of patients with cardiovascular diseases [1–3]. Indeed, this type of training allows patients to develop physical abilities, mainly in the cardiovascular and ventilation systems [4,5]. As an endurance exercise, walking is widely recommended for physical reconditioning [1,6,7]. However, this activity used with poles, as with Nordic walking, allows for travelling a greater distance and at a higher rate [8,9] than without poles.

Nordic walking has benefits for physical endurance capacity among healthy people [6,10,11]. The activity has shown benefits for patients with coronary [12] and arteritis diseases [9,13]. Indeed, Bulinska et al. [13] and Oakley et al. [9] showed a direct effect on increased walk distance for patients with arterial disease. Moreover, Kocur et al. [12] reported significant effects on cardiovascular adaptation to effort, mainly with decreased heart rate at a given intensity and a risk of heart attack level equivalent to that with walking without poles.

Compared to walking without poles, despite greater muscle recruitment, Nordic walking produces no significantly greater

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stress on the heart [14]. Thus, for use in cardiovascular training, Nordic walking may be similar to walking. We aimed to determine whether Nordic walking in a training program differs from walking without poles in increasing the walk distance for patients with acute coronary syndrome (ACS) and peripheral arterial occlusive disease (PAOD).

2. Methods

2.1. Participants

Patients signed a consent form after receiving complete information about the study and the risks, before the start of the protocol. Patients were recruited in a private specialized rehabilitation centre for cardiovascular diseases, treating 250 patients per year, on average. The entire protocol, including patient recruitment, took place over 2 months from September to October 2013.

The centre's physicians determined the inclusion and exclusion criteria. Inclusion criteria were ACS or occlusive peripheral arterial disease, having undergone one or more transluminal angioplasties with stent(s) placement, and able to follow the reconditionning program and tests. Exclusion criteria were sternotomy less than 3 months before the hospital stay, no revascularization [needing angioplasty with stent(s)], a coordination or learning problem concerning the Nordic walking technique, neuromuscular commorbidities (unable to walk), and unstabilized cardiorespiratory status. The patients' main risk factors and medical treatments are in Appendix 1.

2.2. Procedures

Patients were randomly devided into 2 groups by the centre physicians who used a randomization list. Each group performed a training program with 5 sessions per week lasting an effective duration of 45 min. The Nordic walking group (NWG) used Nordic walking for the training and the control group (WG) used walking without poles.

In addition to these training sessions, each patient performed the same reconditioning program including 5 sessions on an ergometrical bicycle, 5 gym sessions and 5 sessions of Adapted Physical Activity per week (Monday to Friday) (Appendix 2), for an effective duration of 45 min each over a total of 4 weeks.

The walk sessions involved a 900-m outdoor flat walking route around the rehabilitation centre. All other activities were held at the center.

The typical day of a patient is in Appendix 2.

2.3. Interventions

Nordic walking sessions involved use of specific poles composed of a handle and an adjustable gauntlet with markers for adjusting height. The pole was made of carbon fiber to combine flexibility and strength but also to limit the weight between 150 and 200 g depending on the size of the pole. The low weight of the pole also limited the risk of injury to the shoulder girdle, which is strongly affected by the weight of the moving object and movement repetitions [7]. A good pole length was determined by the distance between the hand with the elbow positioned at 90 degrees and the ground (a flat surface) when the person was standing.

For each patient in both groups (NWG and WG), the intensity of the training session was fixed in relation to the training heart rate determined by the maximum heart rate recorded during the exercise test, performed at the patient's admission to the centre and with use of the Karvonen formula [15]. The Karvonen formula aims to determine a work intensity based on a percentage of heart rate reserve (HRR), represented by the difference between maximum heart rate and resting heart rate. To maintain a maximum of aerobic impact, this percentage was set at 50%, corresponding to the first threshold or ventilatory threshold 1 [15]. A margin of $\pm$ 10% was tolerated given that maintaining a heart rate beat close to 50% is difficult.

Before Nordic walking sessions, all NWG patients received individual training for 30 min on the handling of poles and the technique of Nordic walking, to discover the activity and become familiar with the most effective movements.

Walking sessions for both groups started after a 10-min warm-up to stimulate and effectively prepare the cardiorespiratory and muscular system for the effort [2,3]. Then, each patient performed a 45-min session of walking at a pace dictated by the training heart rate. All patients were equipped with a heart rate monitor (Polar® FT1). Before each session, resting heart rate and blood pressure were measured. Any heart rate or blood pressure considered excessively high before the activity ($>$ 90 beats/min for heart rate and 150 mmHg for blood pressure) resulted in a medical opinion, after which the patient was or was not allowed to take part in the activity. None of the patients who participated in this study showed values greater than the cutoffs before the activity. Thus, they could all perform the same number of sessions. During these sessions, the patient regularly monitored the heart rate instantaneously to ensure that it corresponded to the training heart rate. After the session, patients performed an activity recovery at low intensity for 5 min.

For all patients, gym sessions and Adapted Physical Activities followed the recommendations of the Group of Exercise Rehabilitation and Sport and the French Society of Cardiology [16] and are presented in Appendix 2.

2.4. Outcomes

The main outcome was walking distance (m). Secondary outcomes were maximum heart rate during exercise (beats/min) and power output (W). All these criteria were measured before and after the training period. The evaluators were blinded to group assignment.

Before the protocol (W0), patients underwent two 6-min walk tests at a 24-h interval to avoid training effects [17]. The best walk distance from both tests was retained. After 4 weeks of exercise training (W4), patients underwent a third 6-min walk test. The same physiotherapist was in charge of all walk tests. Tests were performed indoors over a distance of 30 m delimited by cones. Patients were instructed to walk as far as possible during 6 min. During the tests, the physiotherapist used only standard phrases of verbal encouragement described in the American Thoracic Society statement [17].

Maximum heart rate achieved during the tests was recorded. The 6-min walk test has been described as the most suitable field test and most relevant for assessing patients with cardiac or respiratory failure and in patients with occlusive arterial disease [17]. Test passage modalities complied with the recommendations by Enright [18].

Walk distance was also measured with stress tests on a treadmill before and after 4 weeks of exercise training. Before the protocol (W0), patients underwent a triangular stress test based on a modified Bruce test [19,20]. This stress test complied with the terms described by Broustet and Monpère [21] and validated in patients with arterial disease. The test was stopped when patients reported too much pain or tiredness to continue.

For the treadmill stress test, a power output in Watts was estimated, with the metabolic equivalent of task (MET) of the final level reached at the end of the test [19,22–24]. The estimated power output was based on a relationship between 2 formulas to determine the MET. The first formula determines the MET value depending on the speed and slope reached at the final level of the stress test [24]. The second formula determines the MET value depending on the power output and weight of the participant [22]. At W4, patients underwent a second stress test following the same terms.

2.5. Statistical methods

Sample size estimation: because of lack of literature on this topic, estimating an optimal sample size was difficult. Sample size was estimated according to Cohen's recommendations [25], defining effect-size bounds as small (ES: 0.2), medium (ES: 0.5) and large (ES: 0.8, "grossly perceptible and therefore large"). We estimated that we needed a minimum of 17 patients per group to highlight an effect size of 1 with two-tailed type I error $\alpha = 0.05$ and 80% statistical power. Considering the possibility of follow-up, we finally chose to include a minimum of 20 patients per group.

Quantitative data are expressed as mean ± SD or median (interquartile range) as appropriate. The assumption of normality was tested by the Shapiro-Wilk test. Quantitative data were compared by Student t test or Mann-Whitney test as appropriate. The assumption of homoscedasticity was tested by the Fisher-Snedecor test. Categorical data were compared by Chi^2 or Fisher exact test. Relationships between quantitative variables were determined by Pearson or Spearman correlation as appropriate. Paired comparisons involved paired t test or Wilcoxon test. Statistical analysis involved use of Statistica (StatSoft, Inc., Tulsa, OK, USA). Two-tailed $P < 0.05$ was considered statistically significant.

2.5.1. Ethics

The study was conducted in compliance with the protocol Good Clinical Practices and Declaration of Helsinki principles. In accordance with French law, all patients gave their verbal and written consent to participate after being informed about the study protocol. The participation in the study did not modify usual rehabilitation; the only difference concerned type of walking training.

Table 1
Baseline characteristics of patients with Nordic walking (NWG) and walking without poles (WG).

	NWG, $n = 21$	WG, $n = 21$
Age (years)	56.6 (11)	58 (11)
Height (m)	1.7 (7)	1.68 (6)
Weight (kg)	79 (13)	75 (13)
BMI (kg/m^2)	27.4 (4.5)	26.5 (4.5)
Treadmill		
Maximum heart rate (beats/min)	120 (21)	109 (17)
Walk distance (m)	779 (335)	798 (341)
Power output (W)	105 (33)	96 (20)
6-min walk test		
Walk distance (m)	526 (114)	516 (56)
Maximum heart rate (beats/min)	102 (18)	95 (18)

Data are no. (%) of patients.

3. Results

We included 42 patients with cardiovascular diseases (35 men; mean age 57.2 ± 11 years and BMI 26.5 ± 4.5 kg/m^2). Patients were randomly divided into 2 groups: Nordic Walking Group (NWG, $n = 21$) and Walking Group without poles (WG, $n = 21$)(Fig. 1). The 2 groups did not differ in pathologies: 12 per group had ACS and 9 per group had PAOD. The 2 groups did not differ in baseline age or anthropometric variables (height, weight and BMI); baseline maximum heart rate, walk distance or power output on the treadmill stress test; or baseline walk distance or maximum heart rate on the 6-min walk test (Table 1).

After 4 weeks of exercise training (W4), the NWG and WG showed significant improvement in distance covered on the 6-min walk test: 65 ± 29 m ($P < 0.001$) and 25 ± 35 m ($P < 0.05$) (Fig. 2). Moreover, at the end of W4, the 2 groups showed a significant improvement in distance on the treadmill stress test: 306 ± 178 m ($P < 0.001$) and 230 ± 328 m ($P < 0.05$) (Fig. 2). As well, they showed a significant improvement in power output: 36 ± 26 W and 31 ± 23 W (both $P < 0.001$) (Fig. 3).

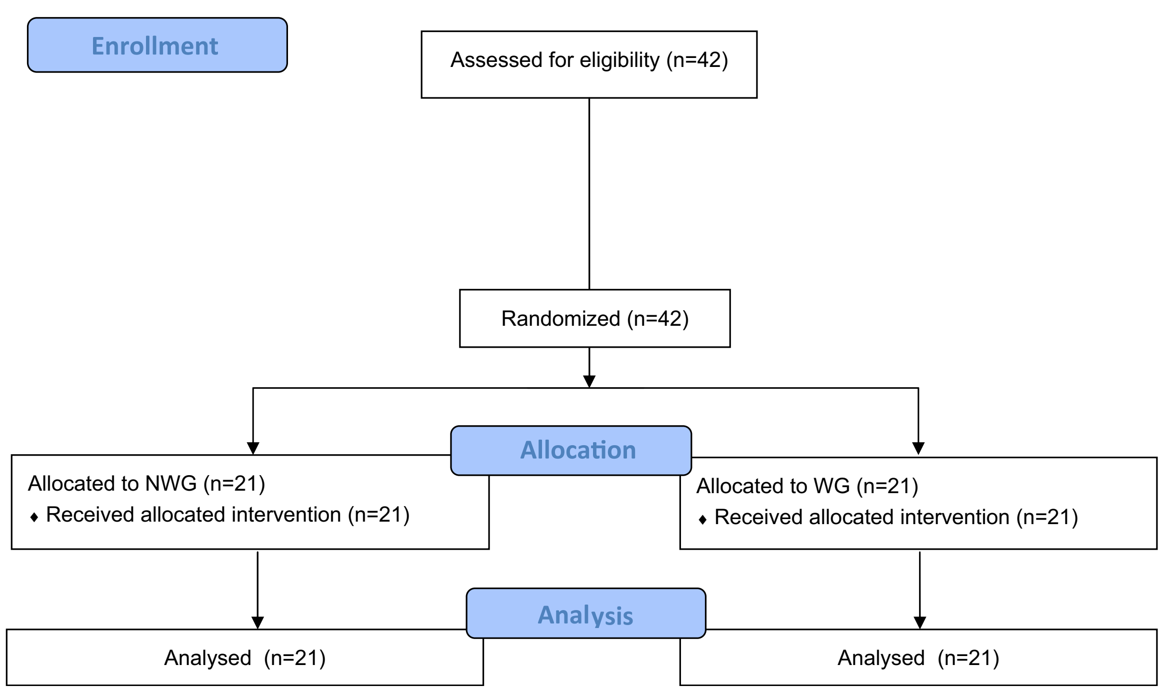

Fig. 1. Flow of patients in the trial.

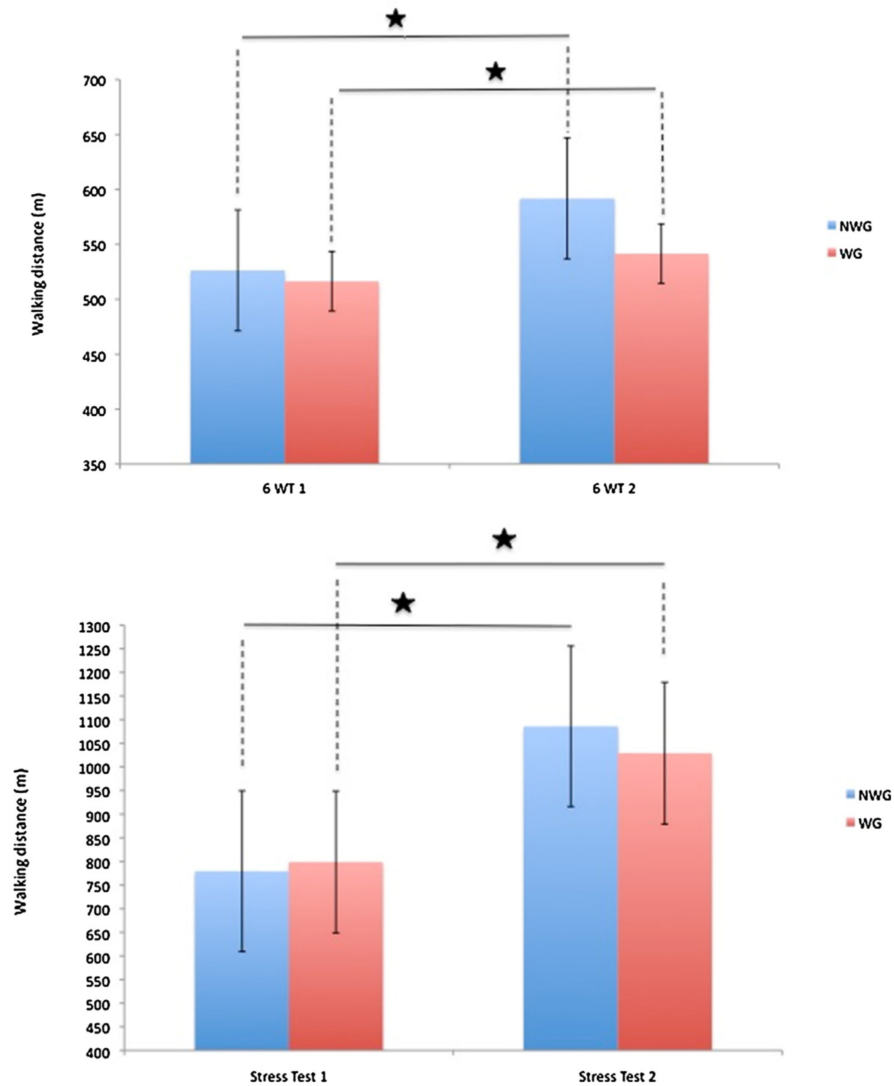

Fig. 2. Comparison of walk distance on the 6-min walk test and treadmill stress test at baseline (W0) and week 4 (W4) after training with Nordic walking (NWG) or walking without poles (WG). Data are mean ± SD. $^{*}P < 0.05$.

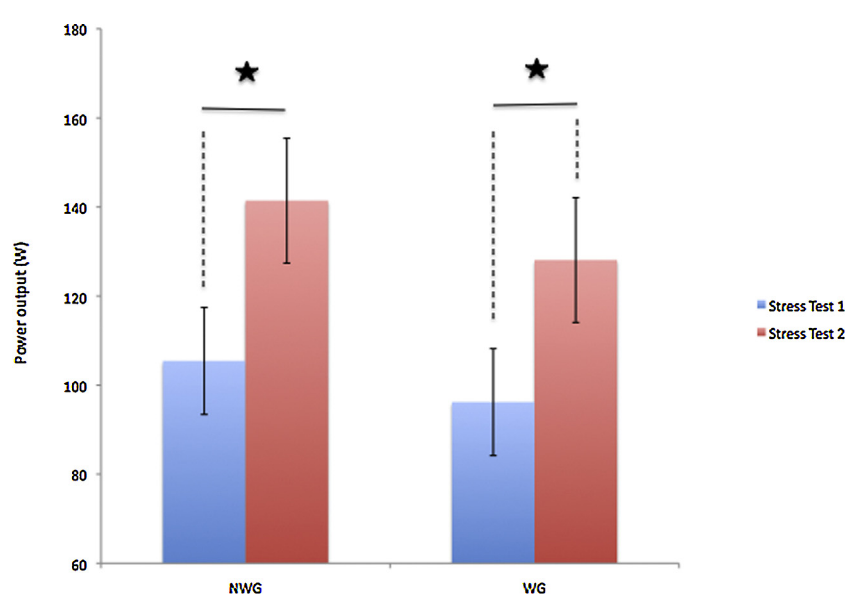

Fig. 3. Power output on the treadmill stress test at W0 and W4 after training. Data are mean ± SD. $^{*}P < 0.05$.

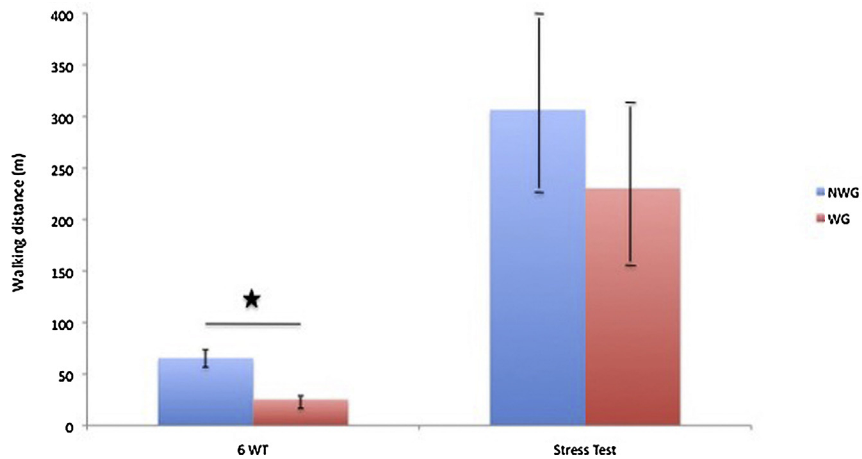

Fig. 4. Gain in walk distance on the 6-min walk test and treadmill stress test from W0 to W4. Data are mean ± SD. $^{*}P < 0.05$.

Table 2
Meaningful clinical improvement in walk distance at week 4 for patients with Nordic walking (NWG) and walking without poles (WG).

	NWG, $n = 21$	WG, $n = 21$	Total
> 36 m gain	18	9	27
< 36 m gain	3	12	15

Data are no. of patients.

At W4, the 2 groups showed a significant difference in gain of distance on both tests ($P < 0.05$). The distance covered during the 6-min walk test was greater, by 40 ± 21 m, for the NWG than WG ($P < 0.001$) (Fig. 4).

Considering pathologies, even though patients with both diseases progressed in each group, at W4, the only significant difference between the 2 groups on the 6-min walk test appeared for the PAOD patients in the NWG, with an increase of 64 ± 31 m ($P < 0.05$) in distance as compared with PAOD patients in the WG. Considering intra-group variations, the two pathology sub-groups in the NWG and WG did not differ in other measured variables during the 4-week exercise training.

Moreover, we found a meaningful clinical improvement in walk distance with the 6-min walk test [25] between the NWG and WG patients ($P < 0.05$ for 1 d.f.) (Table 2). The 2 groups did not differ in distance gains on the treadmill stress test after the training (Fig. 4), nor did they differ in increases in power output during the treadmill stress test at the end of training.

At W4, the 2 groups did not differ in maximum heart rate during the different tests.

As well, we found no significant correlation between the walk distance with both tests throughout the protocol ($r = 0.23$, $P > 0.05$).

We found no significant adverse effects during the training program. The whole group reported no physical pain or problems during the 4 weeks of exercise training.

4. Discussion

We aimed to compare the effect of a short-term intensive training with Nordic walking to walking without poles in standard cardiac rehabilitation care performed in a rehabilitation centre. For patients with ACS and PAOD, after a 4-week training program, both Nordic walking and walking without poles significantly increased walk distance and power output. However, the distance covered during the 6-min walk test was greater with Nordic walking than walking without poles at the end of the training program.

We found a significant progress in walk distance after 4 weeks of exercise training on both the 6-min walk test and treadmill stress test. These results are similar to those reported by Keast et al. [27], who reported a significant increase in walk distance on the 6-min walk test in patients with moderate to severe heart failure after a 12-week training program. Patients awaiting lung transplantation showed a 20% increase in walk distance assessed by the 6-min walk test after a 12-week training program in Nordic walking [28]. Scimia et al. [29] reported 44% improvement with walking without poles in older patients following a program similar to that in our study. Furthermore, the increase in walk distance with the 6-min walk test we found is above the minimal important difference reported by Täger et al. [26] for the same kind of population.

The effectiveness of exercise training in Nordic walking and walking without poles also corroborates the results by Kocur et al. [12] and Kukkonen et al. [6], who reported significant gains in distance on the 6-min walk test with both types of exercise training over periods of 3 to 13 weeks, respectively.

The significant gain in power output during the treadmill stress test for the 2 groups after the 4-week training period was directly due to the gain in walk distance. Thus, the speed reached by patients at the end of trial was greater than previously achieved at W0. Because the MET value is directly affected by speed [24] and directly related to power output [22], an increase in speed would likely result in an increase in estimated power output. This relationship can explain the increase in power output at the end of 4 weeks of exercise training.

Although both groups showed significant improvement on both tests after 4 weeks of the protocol, they showed some differences. Kocur et al. [12] observed a significant difference in progress between a group practicing Nordic walking and one practicing walking without poles. Indeed, the Nordic walking group showed significantly increased MET as compared with the group without poles. This difference may be explained by greater muscle mass recruited during Nordic walking than walking without poles.

However, the results reported by Kocur et al. [12] and by Kukkonen-Harjula et al. [6] on muscle strength with their training protocols showed greater improvement in strength of the knee extensors with Nordic walking than walking without poles. The explanation lies in the significant increase in walk distance with Nordic walking, as reported by Bulinska et al. [13] and Oakley et al. [9]. Indeed, the authors found that walking with poles significantly increased the distance that arteritic patients could reach as compared to the distance walked without poles. The walk distance increased significantly during training sessions in Nordic walking as compared with walking without poles, which suggests greater muscular impact. Moreover, Figueiredo et al. [8] reported a significant increase in walking speed after training in Nordic walking as compared with walking without poles. The combination of these improvements with a Nordic walking training compared to walking without poles explains the significant difference in increased walk distance between the two groups.

However, this difference in walk difference was significant only for the 6-min walk test. For meaningful assessment, the stress test must be as specific as possible, particularly in relation to the characteristics and practice of the patient [2,3]. Palatini [30] observed poor correlation between the intensity levels achieved during a field test and those reached during a treadmill test and that a treadmill test underestimated the person's capacity, in terms of intensity, as compared to a field test. A laboratory test does not faithfully reproduce what occurs in the field. The 6-min walk test is indeed a field test. Thus, compared to a treadmill stress test, the 6-min walk test may produce different results. This difference is explained again by the specificity of the test. Reinisch et al. [31] reported a significant différence in walking pattern between walking performed on treadmill at a given speed and walking on a floor at the same speed. For most people, walking on a treadmill seems daunting and unnatural and so limits the intensity of their maximum effort, mainly because they are afraid of falling, but also by modification of the propulsion phase [31]. The differences between the 2 tests we used helped to explain the results. The 6-min walk test was actually much more specific than the modified Bruce test on the treadmill in assessing patient progress with an exercise training protocol of Nordic walking and walking without poles, on level ground.

The heterogeneity of our patients may be considered a limitation of this study. Nevertheless, the groups contained the same number of patients with each pathology and so could be compared. Moreover, this number is representative of the populations found in most cardiovascular rehabilitation centers. Therefore, we decided to keep these 2 populations in the data analysis.

5. Conclusions

After 4 weeks of a conventional rehabilitation program, Nordic walking was more effective than walking without poles for improving distance on a 6-min walk test. Nordic walking compared to walking without poles had greater impact on functional capacities principally by an increase in walking speed and muscle mass recruitment. According to the patients, Nordic walking was associated with important motivation: they walked faster and longer with than without poles, which increased their motivation to practice. Moreover, the activity is low cost and can be practiced almost anywhere, which could favor continuity of the practice at home after hospital discharge. The practice of Nordic walking can be advised in the treatment of coronary and peripheral arterial disease at any time and can also be used in any rehabilitation training, in the absence of contraindications.

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Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.rehab.2016.12.004.

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