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A randomised controlled cross-over trial of aerobic training *versus* Qigong in advanced Parkinson's disease

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Aim. **To investigate the effects of an aerobic training in subjects with Parkinson's disease (PD) as compared to a medical Chinese exercise (Qigong).**

Methods. **Design: randomized controlled trial with a cross over design. Setting: PD out-patients referred to a Neurorehabilitation facility for the management of motor disability. Subjects: 26 PD patients in Hoehn and Yahr stage II to III under stable medication were randomly allocated to either Group AT1+QG2 (receiving 20 aerobic training sessions followed by 20 "Qigong" group sessions with 2 month interval between the interventions), or Group QG1+AT2 (performing the same treatments with an inverted sequence). Main outcome measures: clinical effects of treatment were sought through the Unified Parkinson's Disease Rating Scale (UPDRS), Brown's Disability Scale (B'DS), six-Minute Walking Test (6MWT), Borg scale for breathlessness, Beck Depression Inventory (BDI) and Parkinson's Disease Questionnaire-39 items (PDQ-39). A spirometry test and maximum cardiopulmonary exercise test (CPET) were also performed to determine the pulmonary function, the metabolic and cardio-respiratory requests at rest and under exercise. All measures were taken immediately before and at the completion of each treatment phase.**

Results. **The statistical analysis focusing on the evolution of motor disability and quality of life revealed a significant interaction effect between group and time for the 6MWT (time x group effect: F: 5.4 P=0.002) and the Borg scale (time x group effect: F: 4.2 P=0.009). Post hoc analysis showed a significant increase in 6MWT and a larger decrease in Borg score after aerobic training within each subgroup, whereas no significant changes were observed during Qigong. No significant changes over time were detected through the analysis of UPDRS, B'DS, BDI and PDQ-39 scores. The analysis of cardiorespiratory parameters showed significant interaction effects between group and time for the Double Product$_{peak}$ (time x group effect: F: 7.7 P=0.0003), the $\dot{V}O_{2peak}$ (time x group effect: F: 4.8 P=0.007), and the $\dot{V}O_2$/kg ratio (time x group effect: F: 4.3 P=0.009), owing to their decrease after aerobic training to an extent that was never observed after Qigong treatment.**

Conclusions. **Aerobic training exerts a significant impact on the ability of moderately disabled PD patients to cope with exercise, although it does not improve their self-sufficiency and quality of life.**

Key words: **Parkinson's disease - Aerobic training - Qigong - Group therapy - PDQ-39.**

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Parkinson's disease (PD) is a progressive neurologic disorder with insidious onset. The clinical hallmarks of the disease include difficulties in starting movements (akinesia), slowness (bradykinesia),

reduced ability to switch between different coordination patterns (set shifting), stiffness in arms, legs and trunk (rigidity), and pathologic tremor at approximately 5 to 6Hz.[1] These impairments lead to a decline in functional status so that PD people cannot cope with tasks such as walking, rising from a chair, and moving in bed. This decrease in functional status often results in a loss of independence and a decline in quality of life (QoL). The rate of progression varies widely among the PD population, with cases taking 4 to 30 years to develop severe disability.[2] Given the large number of people affected by the disease, the long life span after diagnosis, the progressive nature of the illness and the short duration of medication effectiveness, it is important to identify additional interventions to maximize QoL and functional status and minimize the burden on family and health care system.

A number of intervention studies have been carried out to investigate the efficacy of non-pharmacological approaches in addition to drug treatment. While some studies support the positive effects of physiotherapy,[3] occupational therapy [4] and speech therapy in PD patients, others conclude that there is not any evidence to support or refute any specific or general rehabilitation intervention.[5-7]

In a systematic review of available evidences, Gage *et al*.[7] suggest that interventions can affect patients' lives for the better in a variety of ways; nevertheless, the clinical relevance of statistically significant improvements reported in most studies is difficult to interpret. As a matter of fact, international clinical guidelines on PD management underline the benefits arising from staying active, especially in the early phases of disease, by practising aerobic exercises,[8] even if the evidence provided by the few true or quasi-experiment studies investigating the effects of a structured program of physical training is weak and not homogeneous.[9-11]

The purpose of this study was to compare the effects of 7-week aerobic training, added to medication therapy, with the effects of group therapy based on Qigong exercises (a Chinese physiotherapy approach, consisting of breathing exercises associated with stretching and balance training) in patients suffering from mild to moderate PD.

To this end, PD patients in II-III Hoehn and Yahr stage underwent both treatments with 2-month interval between, with the order of treatment being randomly selected for each patient.

Immediate effects after each intervention were assessed through ratings of neurological symptoms and signs, self-evaluation questionnaires of disability and quality of life and objective measures of cardiorespiratory fitness.

Materials and methods

Study design

Randomized controlled trial with a crossover design, taking place during a 6-month period.

Participants

Twenty-six PD subjects, in Hoehn and Yahr stage II-III, under stable medication treatment participated in this study. Patients were not enrolled if they met the following exclusion criteria: 1) severe cognitive impairment (Mini Mental State Examination score <24); 2) concomitant severe neurologic, cardiopulmonary or orthopaedic disorders; 3) specific contraindication to the execution of a cardiopulmonary test or aerobic training;[12] 4) recent participation in any physiotherapy or rehabilitation program during the previous 2 months.

All subjects were required to sign an informed consent document approved by the local ethical committee.

The eligible subjects were randomly allocated to 2 groups. Group AT1+QG2 received 20 aerobic training sessions followed by 20 Qigong group sessions with 2 month interval between the interventions, whereas Group QG1+AT2 performed the same treatments with an inverted sequence (Figure 1).

Randomisation was performed by coupling consecutively eligible subjects to a list of random numbers, corresponding to numbered sealed envelopes concealing group allocation. The investigator who declared patients eligible (M.C.) was not involved in the envelope preparation, that was under the responsibility of the main investigator (M.G.C.). Furthermore, the physiatrist (G.R.) who examined all the subjects, as well as the pneumologist (B.F.) and the cardiologist (C.R.) who analysed the cardiorespiratory tests were blind to treatment allocation. Patients were instructed to provide no information concerning the rehabilitation treatment during assessment sessions.

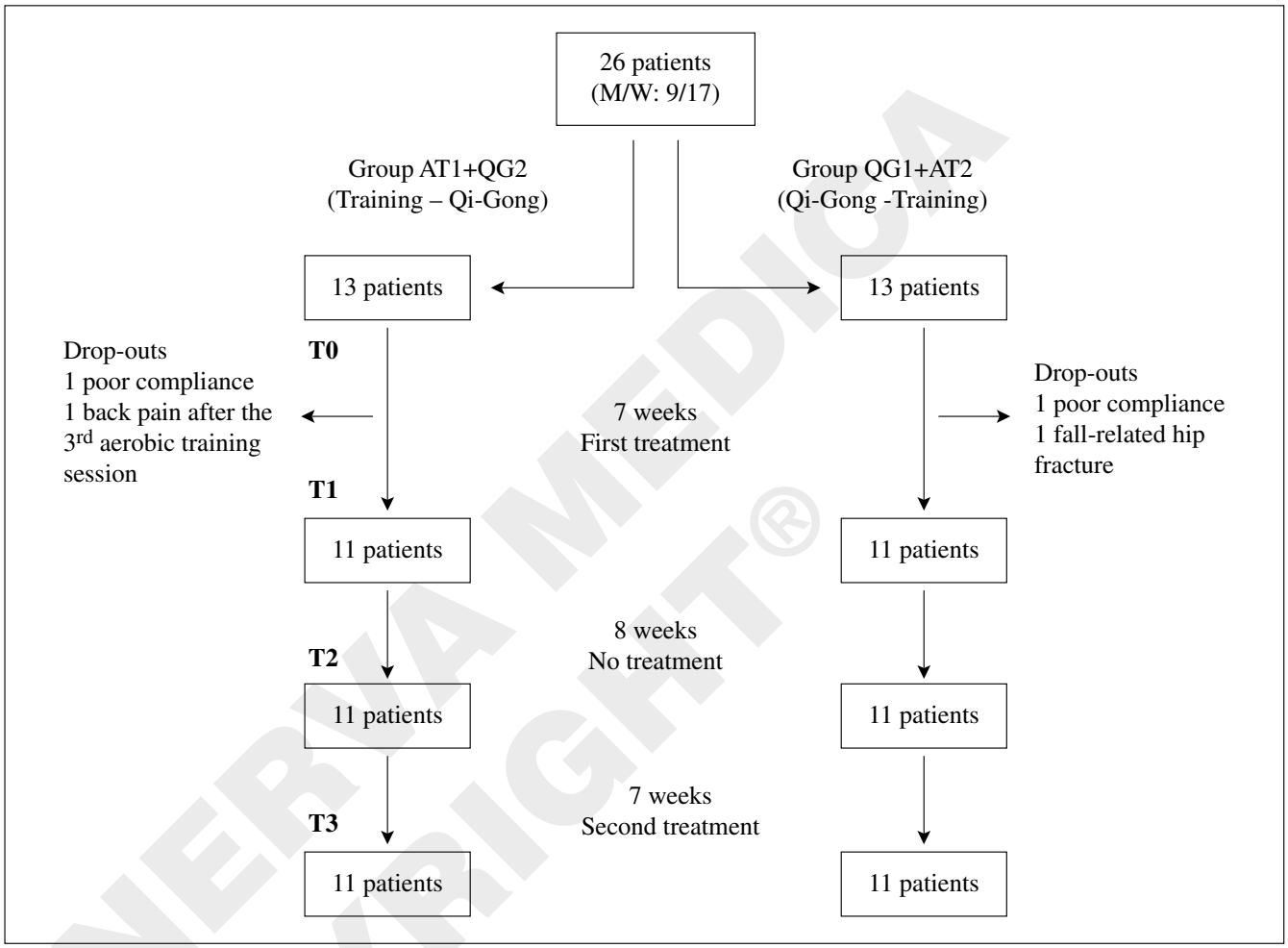

Figure 1.—The picture shows the flow of patients through the study.

Rehabilitation interventions

AEROBIC TRAINING

Patients were divided in 2-people subgroups who performed cycle ergometer, three times per week over 7 weeks for a total 20 sessions. Each session consisted of 45 minutes training on cycle ergometer characterized by three phases: 1) warm-up: 10 minutes of low-intensity exercise sufficient to approach the lower limit of the prescribed exercise; 2) endurance: 30 minutes exercising at an intensity reaching 50% to 60% maximum heart rate reserve [13] and 3) cool-down: 10 minutes of gradual recovery from the endurance phase and stretching exercises. Furthermore, if heart rate did not exceed the quoted range (*i.e.* 50-60% maximum heart rate reserve) for at least 2 consecutive sessions, work load of endurance exercise was increased by 5 Watt, in order to achieve the maximum training efficacy.

QIGONG

Subjects were grouped in 3 to 4-people classes performing 20 sessions at the same frequency and intensity as aerobic training (50 minutes sessions 3 times per week over 7 weeks). Qigong represents a Chinese physiotherapy approach, consisting of breathing exercises associated with stretching, neck and trunk rotation exercises and balance training in the upright position. The accent is put on controlling breathing when

performing slow range of movement exercises, trying to reach the limits of limb ROM and then keeping the posture as long as possible.[14]

After 2-month pause, the treatment was inverted so that all subjects could experiment both interventions.

The same physical therapist (S.I.) was involved in all treatment sessions.

Assessment

Subjects were assessed four times: t0: at baseline, that is during the week immediately preceding the first 7-week treatment; t1: at the end of the first intervention; t2: after 2-month interval/before starting the second treatment and t3: at the end of study.

Data collection was realised at the same daytime for each subject, all tests being performed in the same order, with patients in their best medical condition, that is during a prolonged "ON" phase, in the morning.

We decided to assess different outcome encompassing both neurologic impairment and disease-related disability, mood state and quality of life as well as cardiorespiratory fitness.

The Unified Parkinson's Disease Rating Scale (UPDRS)-III section was used to test the degree and severity of motor impairment.[15] The UPDRS-II section and the Brown's Disability scale (B'DS) were used to measure independence in daily living and the burden of care. The UPDRS-II explores the several domains contributing to disease-related disability although—as its final score mixes impairment and disability items—it is considered conceptually unsound by some researchers.[15] Scores range from 0 (no disability) to 52 (worst state).

The B'DS is a specific and reliable self-evaluation questionnaire addressing domains of instrumental performances and provides information on the difficulties experienced by patients in ADL and leisure activities.[16, 17] The score ranges from 0 (no disability) to 100 (worst possible condition).

The Six-Minute Walking Test (6MWT) was applied as a test of fitness for daily physical activities: this test measures the maximal distance a patient can walk at a self-paced velocity on a flat hard surface over a period of 6 minutes. It evaluates the global and integrated responses of all the systems involved during exercise including motor units and muscle metabolism.[18] The test was performed according to the Six Minute Walking Test Guideline.[19]

The perception of breathlessness during 6MWT was rated by the modified Borg Scale whose scores range from 0 (no symptoms at all) to 10 (maximum breathlessness).[20]

Quality of life was evaluated by the Parkinson's Disease Questionnaire-39 items (PDQ-39) [21] and depression by the Beck Depression Inventory (BDI).[22]

A spirometry test and maximum cardiopulmonary exercise test (CPET) were performed to determine the pulmonary function, the metabolic and cardiorespiratory requests at rest and under exercise.

Exercise was performed through "ramp protocol" at a 10 watt/min increase rate, to allow maximum exercise capacity to be reached between 6 and 12 minutes.[23] Subjects were instructed to pedal at 50 to 60 revolutions per minute and verbally encouraged throughout the test to continue cycling until they could no longer cope with the work load.[24]

The following measurements were recorded at exercise peak, that is over the final 30 seconds of the test: work rate (W_{peak}), oxygen consumption ($\dot{V}O_{2peak}$), $\dot{V}O_2$/kg rate, ventilation (VE_{peak}), respiratory exchange ratio (RER_{peak}), heart rate (HR_{peak}) and double product (DP_{peak}: heart rate x systolic blood pressure). If the subject was unable to complete the whole minute of the final work load, W_{peak} was calculated according to the fraction of the minute completed.[25] $\dot{V}O_2$, VE and HR were also recorded at rest to have a baseline reference point.

Statistical analysis

Given our interest into the impact of exercise on either fitness, disability or patient's well-being in PD, statistical analysis was applied to quantify changes in each specific outcome measure after aerobic training, as compared to benefits induced by Qigong exercises.

The use of a cross-over design was decided in order to reduce both the impact of inter-individual variability by exposing each subject to two different interventions and the effect of disease progression by exposing subgroups to different treatment sequences. Furthermore, a 2-month rest period between the treatment phases was introduced to reduce a potential carry-over effect and reproduce a hypothetical basal condition after the former intervention.

Baseline (T0) clinical differences between groups were assessed by using either the unpaired T-test (parametric measures) or the Mann-Whitney U test (non-parametric comparisons).

The evolution of outcome measures in the two subgroups was compared using a two-way analysis of variance with repeated measures to test the interaction between group and time. When a significant effect was found, post-hoc comparisons were performed (within each group) between T1, T2, T3 scores and baseline values, as well as between T3 and T2 scores, by using either a paired T-test (parametric variables) or a Wilcoxon signed-rank test (non-parametric variables).

The level of significance was set at $P<0.05$.

Results

A total of 26 PD subjects (male/female: 9/17; mean age: 65.2±6.5 years; disease duration: 10.83±4.58 years) met the inclusion criteria, completed baseline assessments and were randomly allocated to either group AT1+QG2 (13 cases) or QG1+AT2 (13 cases). No differences were found between groups with respect to personal and clinical characteristics (Table I).

Twenty-two patients completed the study (Figure 1). Two subjects (1 woman per group, scoring II on the H and Y scale) were dropped owing to poor compliance to the scheduled treatments: they missed some courses during the first 3 weeks, performing a total 4 sessions each and were thereafter excluded from outcome analysis. Other 2 patients withdrew from treatment because of medical complications: a woman (H and Y stage II) from Group AT1+QG2 developed back pain after the 3rd aerobic training session; a man (H and Y stage III), from Group QG1+AT2, had a fall-related hip fracture after the 5th Qigong session. Follow-up data concerning the quoted cases are not available.

The following findings refer to the remaining 22 cases who completed the study protocol. Of them, 20 attended all treatment sessions and 2 missed 1 session.

Outcome measures proved to be similarly distributed in the two subgroups at baseline (Table II).

The statistical analysis focusing on the evolution of motor disability and quality of life measures in the subgroups revealed a significant interaction effect between group and time for the 6MWT (time x group effect: F: 5.4 P=0.002) and the Borg scale (time x group effect: F: 4.2 P=0.009).

Post hoc analysis looking for time effects showed a significant increase in 6MWT after aerobic training within each subgroup (AT1+QG2: T0-T1 comparison according to Wilcoxon test gave a Z value of -2.7, P=0.005; QG1+AT2: Wilcoxon test figures were: -2.3 P=0.01, for T0-T1 comparison, and -2.4, P=0.01 for T2-T3 comparison). By contrast, no significant changes in this parameter were observed during Qigong treatment. Similarly, a significantly larger decrease in Borg score was observed after aerobic training than after Qigong, in both subgroups (AT1+QG2: T0-T1 comparison gave a Z value of -2.9, p=0.003; QG1+AT2: Wilcoxon test gave a Z-value of -2.2, p=0.02 for T2-T3 comparison). In AT1+QG2 group, both 6MWT and Borg scores returned to baseline during the 2-month interval between rehabilitation treatments (within group comparisons of T2 to T0 values did not reveal any significant change) (Table III).

No interaction effects were detected analysing trends in UPDRS-III, UPDRS-II, Brown's Disability index, Beck Depression Inventory and PDQ-39 scores.

The statistical analysis looking into the evolution of quantitative parameters of cardiorespiratory fitness showed significant interaction effects between group and time for the Double Product$_{peak}$ (time x group effect: F: 7.7 P=0.0003), the $\dot{V}O_{2peak}$ (time x group effect: F: 4.8 P=0.007), and the $\dot{V}O_2$/kg ratio (time x group effect: F: 4.3 P=0.009).

Post hoc analysis allowed to observe a significant decrease in all three variables starting, in AT1+QG2 group, after the first intervention period (aerobic training) and even persisting 2 months later. At the end of study, after Qigong, the values had returned to baseline. In QG1+AT2 group, values showed a mild, not significant trend towards increasing since the beginning of study until the start of aerobic training. After this treatment, a significant decrease in all the quoted measures was observed (Table II). Detailed results of post hoc analysis and probability levels are reported in Table III.

TABLE I.—*Personal and clinical characteristics of the study participants in total and by groups.*

	Group A	Group B	All subjects
Patients (N)	13	13	26
Age (years) (mean+SD)	65.7±7	62.7±4	65.2±6.5
Gender (male/female)	5/8	4/9	9/17
Body mass index (mean+SD)	24.6±4.7	24.3±5.8	24.5±4.7
Hoehn andYahr (stage II/III)	3/10	4/9	7/19
Disease duration (years) (mean+SD)	11.2±5.4	10.6±4.8	10.8±4.6

SD: standard deviation.

TABLE II.—*Evolution of outcome measures throughout the study in the two groups. Variables showing a significant interaction effect between group and time have been signed with * (P<0.01) or ** (P<0.001).*

Variable	Group	T0	T1	T2	T3
UPDRS III (median, range)	AT1-GQ2	11 (2-16)	11 (2-18)	11 (2-20)	12 (3-19)
	GQ1-AT2	12 (5-20)	11 (4-21)	13 (5-23)	12 (5-20)
UPDRS II (median, range)	AT1-GQ2	7 (4-13)	7 (2-14)	7 (3-18)	6 (2-14)
	GQ1-AT2	7 (3-18)	8 (3-20)	8 (3-19)	7 (2-18)
Brown's DS (median, range)	AT1-GQ2	13 (1-25)	8 (0-49)	15 (0-42)	15 (0-38)
	GQ1-AT2	16 (3-42)	9 (0-33)	13 (3-25)	10 (1-35)
6MWT (meters) (mean±SD) *	AT1-GQ2	419±65	454±54	400±65	412±73
	GQ1-AT2	405±44	394±77	393±70	455±47
Borg scale (median, range)*	AT1-GQ2	1.5 (1-4)	0.7 (0-3)	1.5 (0-5)	1.5 (0-4)
	GQ1-AT2	2.5 (0-5)	2 (0-4)	2 (0-7)	1 (0-3)
PDQ39 total score (median, range)	AT1-GQ2	25 (10-77)	41 (13-68)	41 (11-74)	39 (13-62)
	GQ1-AT2	45 (11-88)	53 (19-85)	40 (16-77)	42 (19-85)
Beck Depression Inventory (median, range)	AT1-GQ2	10 (0-29)	11 (1-27)	11 (1-28)	10 (4-35)
	GQ1-AT2	15 (0-29)	11 (6-35)	11 (5-29)	14 (4-27)
Heart rate rest (mean±SD)	AT1-GQ2	77±12	72.1±8.8	76.1±7.9	72±4.1
	GQ1-AT2	77.5±9	72±4.7	77±11.3	72.3±9
Heart rate peak (mean±SD)	AT1-GQ2	118.2±16.6	115.5±16.9	123.5±13.2	121.5±8.9
	GQ1-AT2	119.5±11.7	121.7±10.9	117.4±16.7	116.5±16.8
$\dot{V}O_2$ rest (mean±SD)	AT1-GQ2	217.7±66	172±65	230±88	183.3±92
	GQ1-AT2	178.3±81	145.5±78	198±78	154.5±54
$\dot{V}O_2$ peak (mean±SD) *	AT1-GQ2	1202.4±368	1076±325	951±337	1096.4±447
	GQ1-AT2	1064.7±229	1198±345	1158±307	1097±375
VE rest (mean±SD)	AT1-GQ2	11.3±2.5	12.4±2.9	11.9±2.1	12.2±2.3
	GQ1-AT2	11.2±2.1	11.2±2.1	11.3±1.8	11.5±2.1
VE peak (mean±SD)	AT1-GQ2	50.8±13.7	43.2±14	43.2±8	48.4±12.5
	GQ1-AT2	44.3±7.7	47.7±11.3	52.2±16.5	47.7±16.7
RER peak (mean±SD)	AT1-GQ2	1.1±0.07	1.1±0.06	1.1±0.1	1.1±0.06
	GQ1-AT2	1.1±0.07	1±0.03	1.1±0.1	1.1±0.1
Double product peak (mean±SD) **	AT1-GQ2	22274±6133	20050±5473	19805±4904	21422±4981
	GQ1-AT2	19586±3314	19915±5388	19034±4410	15892±4994
Wpeak (mean±SD)	AT1-GQ2	94.2±24.3	96±26.7	91.9±19.5	96.8±22.9
	GQ1-AT2	91.5±23.8	102.5±25.1	97.8±28.7	97.3±31.3
$\dot{V}O_2$/kg rate (mean±SD) *	AT1-GQ2	18.7±5.9	16.8±4.5	16.4±3.6	17.8±5
	GQ1-AT2	17.2±4.8	18.9±6.1	20.2±6.7	16.8±5.5

TABLE III.—Post-hoc *analysis results showing the separate time effects in each subgroup after each study phase in the five outcome measures, where a significant interaction effect was found. Z-values refer to Wilcoxon test comparisons of non parametric variables and T- values to paired T-test findings.*

Variable	Group	Comparisons			
		T0-T1	T0-T2	T0-T3	T2-T3
6MWT (Z-value; P level)	AT1-GQ2	-2.7, P=0.005	NS	NS	NS
	GQ1-AT2	NS	NS	-2.3 p=0.01	-2.4, P=0.01
Borg scale (Z-value; P level)	AT1-GQ2	2.9, P=0.003	NS	NS	NS
	GQ1-AT2	NS	NS	NS	2.2, P=0.02
$\dot{V}O_2$ peak (T-value; P level)	AT1-GQ2	2.1, P=0.05	2.3, P=0.04	NS	NS
	GQ1-AT2	NS	NS	NS	2.1, P=0.05
Double product peak (T-value; P level)	AT1-GQ2	2.3, P=0.04	2.5, P=0.03	NS	-2.5, P=0.03
	GQ1-AT2	NS	NS	NS	4.1, P=0.006
$\dot{V}O_2$/kg rate (T-value; P level)	AT1-GQ2	2.1, P=0.05	2.1, P=0.05	NS	-2.3, P=0.04
	GQ1-AT2	NS	NS	NS	3, P=0.02

NS: not significant.

Discussion

The findings from the present work seem to support the hypothesis that aerobic training of an appropriate length – *i.e.* not less than 7 weeks [13] – exerts a significant impact on the ability of PD patients to cope with exercise, although it does not improve their self-sufficiency and quality of life.

In fact, aerobic training induced significant changes in both clinical and instrumental measures of endurance (6MWT, Borg scale, $\dot{V}O_{2peak}$, $\dot{V}O_2$/kg rate and Double Product peak) in all subjects, when comparing the results with the changes observed during rest periods as well as after the execution of Qigong sessions.

Patients participating in this study are representative of a large proportion of PD subjects living in the community, complaining of mild to moderate motor disability, but still able to walk independently and not yet progressed to the advanced phase of illness where clinical fluctuations and non motor complications become critical markers of the disease.

The preservation of walking ability represents an important premise of a rehabilitation approach aimed at enhancing cardiorespiratory performances, as well as a chance of functional achievement upholding. The small proportion of drop-outs (15%) with respect to the original sample may be considered a further evidence of the feasibility of such approach.

The selection of a cross-over design allowed us to keep under control different independent variables that could have adversely influenced the reliability of the study. On one side, the exposition of the same subjects to different treatment conditions allowed within-group comparisons thus reducing the influence of individual variability; on the other side, the presence of two independent patient groups provided a contemporary control of treatment efficacy, thus ruling out the possible influence of disease progression over time.

In this view, the study design appears to be especially appropriate to the investigation of rehabilitation efficacy in PD where the burden of individual clinical variables is high and the course of disability over time often unpredictable.

Qigong has been recently found to exert a positive influence on self-reported physical activity, fatigue and quality of life in subjects with advanced cancer,[26] as well as in cardiac patients [27, 28] and elderly people with chronic pain.[29] It has been described as an effective complementary therapy for promoting health and wellness and managing chronic conditions in older adults. It is the cornerstone of traditional Chinese medicine and consists of gentle flowing body movements, breathing and quieting the mind. Given its nature, it would have been unrealistic to expect any impact of Qigong on endurance measures, whereas it could have influenced subjective feelings of well-being as well as social participation just giving subjects an opportunity of sharing time with disease-matched patients. As a consequence, it could have modified patient's ability to cope with motor disability and emotional distress, eventually influencing the ratings in all self-evaluation questionnaires.

Cardiopulmonary findings ruled out any improvement induced by Qigong intervention, highlighting the significant effect generated by 7 weeks aerobic training on endurance.

CPET permits objective determination of functional capacity and impairment.

The use of both clinical and instrumental measures of work capacity represents a valuable component of the present study: it allowed to define the effectiveness (that is to say the clinical impact as well as the subjective perception of benefit under the patient's point of view) of aerobic training and to demonstrate its theoretical efficacy (that is the ability of treatment to influence objective physiological indices of endurance) in the studied sample.

The decrease in both $\dot{V}O_2$ and $\dot{V}O_2$/kg at exercise peak observed after aerobic exercise implies a reduction of energy expenditure needed to produce the same amount of work as before starting sessions and may be considered an index of successful training.

Double $product_{peak}$ is an index of O_2 consumption at the heart level; therefore a decrease in such parameter mirrors a better heart performance and is also a marker of functional improvement.

Two open long-term cohort studies have so far described functional achievements in moderately affected PD subjects undergoing intensive standardized exercise training.[30, 31] In the earlier study,[30] 14-week training induced an improvement in motor impairment and disability as well as in indices of subjective well-being, whereas in the latest,[31] both aerobic capacity (as measured by $\dot{V}O_{2peak}$) and movement initiation time ameliorated.

We could not find either any influence of exercise on the severity of neurological symptoms and signs as quantified by the UPDRS, or any significant impact of training on attending disability, or even a homogenous change in subjective well-being after treatment. The discrepancy between global measures of functional

impairment and specific indices of aerobic capacity should not lead to minimise the importance of aerobic training in PD patients. This controlled study underlines the strict reliance of functional gain on the task performed, indicating how endurance exercises may well train the cardiovascular and pulmonary responses to work load though not modify the course of illness or its clinical expression.

Quality of life [32] and depression measures are characterised by high intra-individual variability due to their multifactorial nature and are less prone to be influenced by a rehabilitation approach targeting only one minor component of patient's distress.

Conclusions

In conclusion, moderately disabled PD patients improve both self-reported measures of endurance and aerobic capacity after appropriate training and could therefore benefit of regular exercise as much as normal population, by a reduction of co-morbidity and mortality rate.[33] A long-term follow-up of general health measures should be provided in PD subjects routinely practicing aerobic exercise instead of adhering to a sedentary lifestyle in order to appreciate the real impact of training on preventing functional decline.

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