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GROUP TRAINING IN PARKINSONISM: QUANTITATIVE MEASUREMENTS OF TREATMENT

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ABSTRACT. Ten patients with mild to moderate parkinsonism were tested before and after a 12-week training program. Strength was tested with simultaneous EMG registration in the ankle flexors at different angular velocities using a modified Cybex II equipment. Peak Torque (pT), Torque area (Ta) and Emg area (iEMGa) for the eccentric and concentric contractions were calculated. Quotients-q (Ta)/(iEMG) for evaluation of work per iEMG in concentric and eccentric contractions were calculated. Gait analysis and a questionnaire for evaluation of the functional level were also included. Mean peak torque values did not change with training. Concentric quotients-q between test one and control was significantly lower in 30°/s and 120°/s; eccentric quotient-q was significantly lower in the same velocities but between test 2 and control. No improvement in gait was found. Patient questionnaire ratings did not improve significantly though patients had an overall impression of a beneficial effect of physical therapy. No long term effect was found. The results showed with the measuring methods presented no consistent measurable effect from group training in Parkinson's disease.

Key words: exercise, gait, isokinetic, measurement, physical therapy, parkinsonism, rehabilitation.

In Parkinson's disease (PD) physical therapy is used extensively in conjugation with medical therapy, even though conclusive evidence regarding effectiveness has never been presented. Even this paper does not present conclusive evidence of a positive effect of group training. Subjective assessments of group therapy have been made and the general impression has been positive (7, 9, 13, 14). A decrease in bradykinesia has been reported. It has also been postulated that after training patients are better able to perform activities of daily living (5, 6, 7, 15). Several functional tests for evaluating the effects of physical therapy have been developed (9, 12), but objective methods for quantifying the effects are seldom used. In an attempt to verify whether group therapy can be beneficial to Parkinson patients we developed a training program designed for these patients. Using modified Cybex II equipment (Lumex, Bayshore, New York), the patients were tested both before and after training for isokinetic concentric and eccentric muscle strength in the ankle dorsiflexors. At the same time gait analysis and clinical evaluation were also carried out.

PATIENTS

The test group consisted of ten patients (5 men and 5 women, mean age $x=66.5$ years, SD$=7.25$) with mild to moderate parkinsonism (Hoehn and Yahr 1–3) (10), and a duration of disease of $x=5.3$ years, S.D.$=2.1$ years. With one exception all patients were taking ordinary antiparkinson drugs and all were in a clinically stable condition. No change in medication was made during the trial. None of the patients had any other major disease. One of the patients did daily gymnastic exercises, but no one in the group participated in organized training. All were out-patients and all volunteered after giving their informed consent. One patient did not want to complete the training and was therefore excluded. The study was approved by the local Ethics Committee.

METHODS

The training program emphasized dynamic movements with variation in speed and adjustment to space. The types of exercises which were used are presented in Table I. The exercises were accamponied by music. The patients participated in group training, in one-hour sessions two times a week for twelve weeks, and were also given special instructions for exercising at home. The patients were tested with a standardized method (18) both before and after the 12-week training period. Four months after the training was completed the patients were retested (control). Patients were tested at the same time of day, preferably before lunch. Each patient was used as his own control. Testing of patients' general physical condition was not performed.

For objective evaluation of treatment two methods (gait analysis and muscle strength measurement) were used. Both have previously been used in the description of the symptoms of Parkinson's disease and have in other medical disciplines proved useful in evaluation of given treatment. Both describe motor function but under different circumstances (with and

Table I. *List of items in the training program*

Initial warm-up with different gait exercises
Standing and sitting ball-throwing exercises to increase coordination and motility
Foot and leg exercises with varied speed to increase strength, motility and coordination in the sitting and erect positions
Exercises in the recumbent position for improving strength, mobility and coordination in abdominal, back and hip muscles
Training exercises for balance and postural control for pairs of patients using footballs
Circular training court equipped with physical obstacles which are to be climbed over as fast as possible
Post training relaxation period

Table II. *List of items in the questionnaire*

Name and age
Occupation
Degree of daily exercise
Subjective impression of rigidity
Difficulties in gait and postural control
Tremor
Spasm and muscular pain
Muscle weakness
Difficulties in activities of daily living
Daily symptom fluctuations
Evaluation of effects of training

without postural involvement). Isokinetic muscle strength measurements during eccentric and concentric contractions were obtained using modified Cybex II equipment. Tests of strength were done at different angular velocities (0–30–120–180°/s). Torque curves for eccentric and concentric muscle contractions were recorded. The patients were informed of the purpose of the study and they were given verbal encouragement during the tests.

Simultaneous electromyographic (EMG) recordings were made over the muscle bellies of the anterior tibial muscle and the triceps surae. Self adhesive silver/silver-chloride electrodes were used with an interelectrode distance of 2–3 cm. Impedance was kept below 5 kohm. The recording system consisted of skin electrodes, amplifiers and an RMS detector. The results were recorded on an electrostatic recorder (ES 1000 Gould). Specifications for preamplifier: gain 60 dB (voltage), frequency range upper (−3 dB point) 2 kHz, lower (−3 dB point) 6 Hz, CMRR 100 dB. Specifications for the amplifier and the RMS detector: gain 20 dB (voltage), bandwidh DC-2 kHz. The RMS detector detects true RMS values and consists of an integrated circuit (AD 536 Analog devices).

Peak torque (pT), torque area (Ta), integrated emg (iEMG) were calculated during both the eccentric and the concentric contractions. The quotient between Ta/iEMG (quotient-q) was calculated to see if the relation between work performed and iEMG was changed. Area calculations for torque and emg were performed using a Digitizer (Houston Instruments, Houston, USA). Muscle strength during the eccentric and the concentric contractions was only tested in the left leg, irrespective of where the patients had the most marked symptoms and whether it was the patient's dominant or non-dominant leg. The test session was completed with a gait analysis in which the patient walked a distance of ten metres using five different paces ranging from the fastest they could go to the slowest. Basal parameters of gait (stride frequency, stride length, velocity of gait) were calculated after two to three trials at every pace. Regression coefficients between stride length and stride frequency was calculated for obtaining stride length at constant velocity.

For evaluation of motor function we tested gait as well as isokinetic muscle strength. Both are needed to differentiate between the influences of central and peripheral factors on muscle performance. With this in mind we considered the methods used sufficient to detect an effect of the given treatment (13, 18). The present methods have been used for describing motor disturbances and training effects in other diseases.

Table III. *Peak torque*

Data given as mean and, in parentheses, standard deviation

Test	Isometric	30°/s	120°/s	180°/s
Concentric peak torque (pT) values before and after training (Nm)				
Before[a]	32 (15)	32 (12.6)	11.2 (8.8)	8.8 (6.6)
After[b]	24.7 (8.9)	20.7 (9.3)	9.1 (6.3)	5.9 (3.9)
Control[c]	25.6 (12.4)	19.0 (8.6)	11.0 (6.5)	8.8 (6.4)
Eccentric peak torque (pT) values before and after training (Nm)				
Before[a]		37.5 (14.8)	37.4 (14.6)	40.8 (16.3)
After[b]		35.3 (14.5)	38.1 (13.5)	39.3 (14.4)
Control[c]		38.2 (12.9)	37.3 (12.4)	40.7 (12.7)

[a] Before training. [b] After training. [c] Control four months after training.
Significant change indicated by *, $p<0.05$.

Table IV. *Quotient-q (torque area/EMG area)*

Data given as mean and in parentheses, standard deviation

Test	30°/s	120°/s	180°/s
Test values for concentric quotient-q (Ta/iEMGa)			
Before[a]	4.14 (3.65)	1.51 (1.28)	1.72 (1.98)
After[b]	2.60 (2.06) *[1]	0.96 (0.80) *[1]	0.82 (0.53)
Control[c]	1.21 (0.50)	0.61 (0.41)	0.63 (0.38)
Test values for eccentric quotient-q (Ta/iEMGa) contraction			
Before[a]	5.69 (7.0)	4.87 (4.71)	4.14 (2.55)
After[b]	4.82 (2.92)	4.20 (2.73)	4.26 (2.74)
Control[c]	2.19 (1.33) *[2]	2.73 (1.58) *[2]	2.92 (1.57)

[a] Before training. [b] After training. [c] Control four months after training. [1] Indicates significant changes between test one and test three (control), [2] between test two and test three (control).

Significant change indicated by *, $p<0.05$.

In addition a patient questionnaire regarding the patient's own impression of his disability at the present time was answered before each test session. The questionnaire included several aspects of Parkinson symptoms (Table II). Visual analog scales (VAS-scales) were used for self estimation of functional (gait, tremor, rigidity, ADL) level at the time of testing. Patients should also evaluate the group training and describe in what way they experienced the effect of training.

Standard statistical methods were used including the Student *t*-test (paired sample test) and Wilcoxon's rank sum test. Sign test was used for analysis of the questionnaire. Data are presented as mean and standard deviation.

RESULTS

Peak torque

There was no significant change in peak torque before and after training and at the 4 months control (Table III).

Quotient-q

Concentric contraction (torque area/iEMG area). There was a significant decrease in quotient-q in the concentric contraction at 30°/s ($p<0.05$) and 120°/s ($p<0.05$) between the first test and at the 4 month control, but otherwise no significant change was found (Table IV).

Eccentric contraction (Torque area/iEMG area). No significant change was found in the quotient-q after training; only between the second test and the control a significant decrease in quotient-q was found during 30°/s ($p<0.02$) and 120°/s ($p<0.04$) (Table IV).

Electromyography

Musculus triceps surae showed no coactivation during contraction of musculus tibialis anterior in muscle strength measurement.

Gait

The gait analysis showed a significant decrease in maximum velocity after training ($p<0.03$). Significant decrease in stride length was found and results are presented as stride length at constant velocity at 0.5 m/s ($p<0.04$) and 1.1 m/s ($p<0.05$) after training (Table V).

Questionnaire

The results of the questionnaire were not conclusive. According to the evaluations with the VAS-scales there was no significant improvement in the items asked about. In spite of this, all the patients found it beneficial to attend physical training sessions even though they may have indicated in the questionnaire that their functional ability had not improved.

DISCUSSION

Even though the use of group therapy in Parkinson's disease is widespread some controversy still remains

Table V. *Gait*

Gait parameters, maximum velocity and stride length (SL). Data given as mean and, in parentheses, standard deviation

Test	Max. vel. (m/s)	SL (m) at 0.5 m/s	SL (m) at 1.1 m/s
Before[a]	1.63 (0.34)	0.89 (0.13)	1.26 (0.11)
After[b]	1.27 (0.46) *[1]	0.74 (0.12) *[1]	1.14 (0.18) *[1]
Control[c]	1.48 (0.39)	0.76 (0.13) *[2]	1.12 (0.16) *[2]

[a] Before training. [b] After training. [c] Control four months after training. [1] Indicates significant changes between test one and test two, [2] between test one and test three (control).

Significant change indicated by *, $p<0.05$.

in regard to the effects (4, 5, 7). The purpose of this study was to test the effect of a group-training program for patients with PD using motor function test. Results from previous studies are inconsistent and inconclusive (for a review see Palmer et al. 1986 (14)), but the general impression is that there is a positive psychological effect from group training (5, 9).

Measurement of time is often used in the evaluation of training effects. We did not approach this line of strategy but wanted to see if patients were capable of improvement in motor capability by improving muscle strength and gait.

In this study we found no improvement of muscle strength. Significant changes in mean peak torque were not found and the decrease in quotient-q was not consistent.

It is well known that gait is affected in Parkinson's disease (11, 13), but we found no explanation for the decrease in maximum gait velocity and stride length at constant velocity after training. The results were difficult to interpret. Maybe they could be explained by the daily fluctuations in symptoms experienced by many patients. The patients' VAS evaluation of their functional ability indicated no improvement after training, but they all had positive attitudes towards the given group training. This is also the impression obtained from other studies (1, 2, 13, 16). The discrepancies between objective and subjective results could be explained by the short period of training or by decreased psychosocial discomfort.

Assuming that the trainability of Parkinson patients and normal individuals is equal, effect from training would be expected. To explain the lack of effect in this study it could be assumed that the patients' responsivity to training was decreased because of their relative immobilization and the secondary atrophy of fast muscle fibres (3). It is also possible that diseases of the central nervous system reduce the ability to benefit from group therapy when weakness is not due merely to the effect of disuse or when there is no weakness but a lack of activation. Recruitment patterns have been shown to be disrupted in PD. The high mean age of these patients should not influence the test results negatively, since it has been proved that it is still possible to increase strength in old age (with individual training), (8, 17).

With the present methods, and testing a group of limited size no effects of group training were found on the motor symptoms of Parkinson's disease. However, the patients' subjective impression of beneficial effects from training stand firm, and therefore group training in order to alleviate psycho-social discomfort should be considered. We believe that physical training should be regarded as an important part of management and rehabilitation in Parkinson's disease. This conclusion is in line with that of other authors (4, 5, 6, 7, 14, 15).

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