

## SHORT COMMUNICATION

# EFFECTS OF RESISTANCE TRAINING IN COMBINATION WITH COENZYME Q10 SUPPLEMENTATION IN PATIENTS WITH POST-POLIO: A PILOT STUDY

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**Objective:** Coenzyme Q10 supplementation leads to increased muscle metabolism in patients with post-polio syndrome. The aim of this study was to investigate the effect of resistance training in combination with oral supplementation with coenzyme Q10 in patients with post-polio syndrome regarding muscle strength and endurance as well as functional capacity and health-related quality of life.

**Design:** Parallel randomized, controlled, double-blind pilot study.

**Patients and methods:** A total of 14 patients (8 women and 6 men) with post-polio syndrome participated in a 12-week muscular resistance training, 3 days/week. The patients were randomized for oral supplementation with coenzyme Q10, 200 mg/day, or placebo. Measurements used were: sit-stand-sit test, timed up & go test, 6-minute walk test, muscle strength measurement by means of dynamic dynamometer and short-form (SF)-36 questionnaire.

**Results:** Muscle strength, muscle endurance and quality of life regarding mental health increased statistically significantly in all 14 patients. There was no significant difference between the coenzyme Q10 and placebo groups regarding muscle strength, muscle endurance and quality of life.

**Conclusion:** There was no effect of coenzyme Q10 supplementation during resistance training on post-polio syndrome symptoms. Thus, supplementation with coenzyme Q10 has no beneficial effect on muscle function in patients with post-polio syndrome.

**Key words:** quality of life, muscle strength, post-polio syndrome, Q10, resistance training.

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## INTRODUCTION

Individuals who have had poliomyelitis are at risk of developing new or increased symptoms, called post-polio syndrome (PPS). Common symptoms of PPS are muscle weakness and fatigue (1). Several studies have shown that muscle resistance

training in the post-polio population increases strength and/or performance (2). In a study by Mizuno et al. (3) supplementation with coenzyme Q10 (Q10) resulted in increased muscle energy metabolism in patients with PPS. The present study contained few patients, but nonetheless patients with PPS take Q10 in order to increase muscle strength and function.

The purpose of the present study was to evaluate the effect of resistance training combined with oral supplementation with Q10 in patients with PPS regarding muscle strength, functional ability, muscle endurance and health-related quality of life.

## METHODS

The study was carried out as a randomized, placebo-controlled pilot study in which the patients were randomized to resistance training, combined with supplementation with Q10 or placebo treatment, respectively.

### Patients

Patients undergoing treatment, with a clinically (1) and neurophysiologically verified diagnosis of PPS, who were able to walk with or without a walking aid for 6 min and were younger than 80 years of age were recruited (for patient characteristics see Table I). Five patients walked unaided and 5 used a stick or a crutch when walking. One walked with 2 sticks, 2 used walkers and one used a wheelchair or 2 crutches.

### Exercise programme

Resistance training (including a 10 min warm-up with an intensity corresponding to 10–11 on the Borg Rate of Perceived Exertion scale (4)) was performed over a period of 12 weeks, at a frequency of 3 sessions/week, and a duration of 30 min/session. The initial work-load was 50–60% of 1 repetition maximum (1RM) and was successively increased to an intensity of 70–80% of 1RM. This intensity has been used in previous exercise studies with patients with PPS (5). 1RM was tested continuously during the 12 weeks and the work-load adjusted to make sure that the correct exercise intensity was used. The patients performed cable rear pull downs, knee extensions, arm presses and thoracic/lumbar rotation (2 sets of 10 repetitions/machine). In addition, toe heaves were performed on a surface at an angle of 10 degrees (1 set, maximum number of repetitions/leg).

Q10 was administered orally in doses of 2 × 100 mg/day over a period of 12 weeks to half of the patients and the other half were given a placebo.

### Outcome measures

The following measurements were performed at baseline and after the 12-week observation period. Sit-stand-sit (SSS) test (6) was used

Table I. Patient characteristics. Time since acute polio, age at examination, body length, body weight, body mass index, exercise participation and gender in the patients with post-polio syndrome. Median and quartiles for respective groups (Q10 = supplementation with coenzyme Q10, pl = placebo) and for both groups (Total)

	Q10		Pl		Total	
	Median	Q25–Q75	Median	Q25–Q75	Median	Q25–Q75
Polio duration, years	63	62–68	61	56–63	62	60–64
Age at examination, years	71	66–75	66	64–70	69	66–72
Body length, m	1.69	1.62–1.74	1.64	1.62–1.73	1.69	1.62–1.73
Body weight, kg	70	60–85	85	54–92	74	59–91
BMI	24	23.1–32.0	28.7	20.6–31.7	26.6	22.4–31.8
Participation, %	94	92–97	94	78–97	94	88–97
Gender, men/women, n	2/5		6/1		8/6	

Q25–Q75: quartiles 25% and 75%, respectively; BMI: body mass index.

for measurement of muscle strength. Timed up & go (TUG) test was performed according to Podsiadlo & Richardson (7) and used for measurements of functional capacity. The 6-minute walk test (6MWT) (8) was used for measurement of muscle endurance. The best result (walking distance) of 3 attempts was used. All patients used the same walking aid at the baseline measurement and after the observation period. The patients used their ordinary shoes and were not given any physical assistance. Borg scales were used (4).

Muscle strength and endurance of the knee extensors were tested with an isokinetic dynamometer (Kin-Com 125 E Plus, Chattecx Chattanooga, USA). Measurements were performed on a leg muscle with a muscle strength of approximately 25–75% of normal expected muscle power as judged by a clinical examination. A learning session was carried out 1–6 days before the first test. The patient was seated with their back against a backrest with a seatbelt strapped around their chest and the tested leg, and the ankle fastened to the dynamometer arm. The anatomical axis of the knee was aligned with the axis of the dynamometer, and the distal aspect of the arm of the dynamometer was placed 2 cm proximal to the medial malleolus. Dynamic knee extensor strength was measured at a velocity of 60°/sec and with a passive return to start position. Start force was set to 15 N and the range of motion was 90–30° (0° straight leg). Gravity correction was done at 45°. Warming-up consisted of 4–5 submaximal isokinetic concentric contractions. Maximal voluntary dynamic strength was evaluated by 3 concentric contractions with good reproducibility with one minute

rest between, the maximal peak torque (Nm) was calculated. After 5 min rest muscle endurance was measured at a velocity of 120°/sec and with a passive return at a velocity of 60°/sec. Start force and the range of motion was the same settings, but no gravity correction was done. The maximal number of repetitions was 50. Three patients were not able to perform 50 repetitions. The same number of repetitions was performed before and after the training. Total work (J) of the repetitions was calculated.

Health-related quality of life was estimated using the SF-36 questionnaire according to Sullivan & Karlsson (9).

Laboratory data, creatine kinase (CK) and lactate dehydrogenase (LD) were measured before and after training.

#### Statistics

The statistics program SPSS (version 14.0) was used for calculation of data. Demographic data and laboratory data was analysed descriptively. Quantitative data were not normally distributed and therefore non-parametric statistics were used. Wilcoxon signed-rank test was used to analyse differences within groups and Mann-Whitney *U* test for differences between groups. A  $p < 0.05$  was taken as statistically significant.

#### Ethical aspects

The study was approved by the regional ethics committee in Stockholm, Sweden (D: nr 2005/1517-31/2).

Table II. Results of sit-stand-sit (SSS) test, timed up & go (TUG) test, 6-minute walk test (6MWT), muscle strength and total work in the patients with post-polio syndrome. Median and quartiles before and after training for the respectively group (coenzyme Q10 (Q10) and placebo (Pl) groups) and for both groups (Total). *p*-value and the difference in percentage (Diff%) (median and range) is given for each group and *p*-value for the difference between the Q10 and placebo groups (Pl-Q10) is given

		<i>n</i>	Before		After		<i>p</i> -value	Diff %		Pl-Q10
			Median	Q25–Q75	Median	Q25–Q75		Median	Q25–Q75	<i>p</i> -value
SSS test, sec	Pl	7	18	16–25	16	15–24	0.018	6	4–18	
	Q10	7	23	19–29	21	20–26	0.107	11	–5–13	0.902
	Total	14	20	17–26	20	15–24	0.010	9	4–16	
TUG test, sec	Pl	7	10	9–12	11	9–13	0.666	–4	–6–5	
	Q10	7	14	10–19	12	9–23	0.893	0	–6–12	0.620
	Total	14	12	10–16	12	9–14	0.823	0	–6–9	
6MWT, m	Pl	7	274	240–360	283	257–369	0.237	6	–5–15	
	Q10	7	260	235–351	271	242–376	0.028	6	3–11	0.902
	Total	14	271	239–355	279	253–371	0.017	6	1–14	
Muscle strength, Nm	Pl	7	77	57–101	83	63–122	0.172	11	0–21	
	Q10	7	82	24–85	82	29–95	0.237	12	–4–21	0.902
	Total	14	82	57–88	83	57–97	0.046	11	–1–21	
Total work, J	Pl	7	1136	664–1884	869	721–1701	0.933	–4	–24–14	
	Q10	7	1516	323–1690	1564	277–1740	1.000	–1	–12–9	0.902
	Total	14	1332	595–1706	1319	610–1711	0.900	–1	–12–10	

Q25–Q75: quartiles 25% and 75%, respectively.

## RESULTS

All 14 patients completed the exercise period. Participation was good, with a median of 94% (Table I). SSS test and 6MWT (Table II) showed a statistically significant ( $p=0.010$  and  $p=0.017$ , respectively) improvement when data for both groups were analysed together before training as compared with after training. For the 6MWT the Q10 group showed a statistically significant ( $p=0.028$ ) improvement and for the SSS test the placebo group showed a statistically significant ( $p=0.018$ ) improvement when data before training were compared with those after training. For SSS test there was no significant improvement for the Q10 group and for 6MWT there was no significant improvement for the placebo group. There was no statistically significant difference between the Q10 and the placebo group for either SSS test or 6MWT. TUG test (Table II) results were unaltered when the results of both groups together before training were compared with data after training. There was no statistically significant difference between the Q10 and the placebo group.

The muscle strength test (Table II) showed a statistically significant ( $p=0.046$ ) improvement for both groups together but not for the individual groups. There was no statistically significant difference between the Q10 and the placebo group for the muscle strength test. There was no change in total work for both groups or for the individual groups.

Mental health showed a statistically significant improvement ( $p=0.050$ ) for both groups together when data before training were compared with those after training. There was a statistically significant improvement ( $p=0.034$ ) in mental health for the placebo group, whereas there were no statistically significant difference for the Q10 group in any of the sub-domains. When analysing as a whole and the different sub-domains there was no statistically significant difference when data were compared between baseline and after training between the Q10 or the placebo group.

Laboratory data, CK and LD, did not differ when data before training were compared with those after training. There were no differences between the groups.

## DISCUSSION

The results of this study show that a 12-week resistance training programme leads to an increase in muscle strength and endurance as measured by 6MWT and increased quality of life for the SF-36 sub-domain of mental health. This is in accordance with several previous studies reporting increased physical function for PPS patients after training (for reference see Agre (5)).

There was, however, no difference in outcome if the patients took Q10 supplementation or not. The increase in 6MWT in

the Q10 group might suggest increased muscle endurance. On the other hand, the results of the other tests including total work did not support this assumption. Furthermore, there was no improvement in quality of life by means of SF-36 with the exception of mental health.

Mizuno et al. (3) described an increase in muscle metabolism in patients with PPS during Q10 supplementation. However, the results of the present study do not provide any evidence that Q10 increases the muscle metabolism in a way that results in an increase in the muscle strength or function. In conclusion, the present study does not show any beneficial effect of Q10 supplementation on muscle function in patients with PPS.

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## REFERENCES

1. Halstead LS, Rossi CD. New problems in old polio patients: results of a survey of 539 polio survivors. *Orthopedics* 1985; 8: 845–850.
2. Agre JC, Rodriguez AA, Franke TM. Strength, endurance, and work capacity after muscle resistance training in post polio subjects. *Arch Phys Med Rehabil* 1997; 78: 681–686.
3. Mizuno M, Quistorff B, Theorell H, Theorell M, Chamce B. Effects of oral supplementation of coenzyme Q10 on <sup>31</sup>P-NMR detected skeletal muscle energy metabolism in middle-aged post-polio subjects and normal volunteers. *Mol Aspects Med* 1997; Suppl 18: 291–298.
4. Borg G, editor. *Borg's Exertion and pain scales*. Champaign, IL: Human Kinetics; 1998.
5. Agre JC. Exercise in the treatment of post-polio syndrome. In: Silver JK, Gawne AC, editors. *State of the arts reviews*. Philadelphia: Hanley Belfus; 2004, p. 117–143.
6. Whitney SL, Wrisley DM, Marchetti GF, Gee MA, Redfern MS, Furman JM. Clinical measurement of sit-to-stand performance in people with balance disorders: validity of data for the five-times-sit-to-stand test. *Phys Ther* 2005; 85: 1034–1045.
7. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc* 1991; 39: 142–148.
8. Harada ND, Chiu V, Stewart AL. Mobility-related function in older adults: assessment with a 6-minute walk test. *Arch Phys Med Rehabil* 1999; 80: 837–841.
9. Sullivan M, Karlsson J. The Swedish SF-36 health survey III. Evaluation of criterion-based validity: results from normative population. *J Clin Epidemiol* 1998; 51: 1105–1113.