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Finger Tapping Test as a useful measure in the evaluation of motor performance in patients with myasthenia gravis

Myasthenia gravis (MG) is an autoimmune disorder of neuromuscular transmission characterized by increased fatigability of voluntary muscles with constant fluctuations. In this paper we present detailed Finger Tapping Test data (1) obtained from MG and control subjects, following a standardized assessment procedure.

The aim of our study was to analyse if FTT data could show not only motor slowness in MG patients but also fatigability effect in standardized testing.

MATERIAL AND METHODS

Patients and controls

38 patients with *myasthenia gravis* and 30 healthy subjects volunteered for the study. Both groups were age, sex (χ^2=0.006; P=0.94) and education matched (Table 1). All of the patients were recruited from *Myasthenia Gravis* Outpatients' Clinic. Diagnosis was confirmed by means of electromyography results, the presence of antinicotinic antibodies in serum and a positive Tensilon Test.

According to the Oosterhuis criteria (2) disease severity was assessed as zero in 7 patients, one in 16 patients, two in 8 cases, three in 5 patients and four in one subject. Following Osserman's classification (3) 7 patients were classified as one (ocular myasthenia) and 31 as two (generalized myasthenia; 2a – 19 cases, 2b – 7 cases, 2c – 4 cases). The time since disease onset averaged 8 years (SD 6). 21 patients were treated only with parasympathomimetics, 13 with both parasympathomimetics and steroids, 2 apart from the aforementioned treatment took also immunosuppressive medication and 1 received no pharmacological treatment. Seven patients (18.4%) suffered from myasthenic crisis. Among MG patients 23 (60.5%) were thymectomized. The average time period between thymectomy and the testing was 8 (SD 6) years. All the patients took usual medication dose on the day of examination.

Clinical ratings

Monitoring changes in the patient's motor performance implies either use of quantitative scales such as *Myasthenia gravis* impairment scale (4), which rely to a great extent on the examiner's clinical experience, or subjective measures such as English *Myasthenia Gravis* Questionnaire (5) and MG

disability scale (6) which focus on the subjective experience of symptoms. Alternatively, other scales are based on interview but refer rather to severity of symptoms than disability in daily activities (7). In the latter case, it is impossible to distinguish between objective and subjective information. Using scales that were developed for other conditions seems questionable (8).

Quantitative scales offer limited results range for each aspect of motor performance, e.g. 0–3 for upper limb girdle – like in the MG impairment scale (4). This seems unsatisfactory to detect subtle changes in motor speed, that may be important for example in monitoring the efficiency of pharmacotherapy. In cases where precise assessment of motor speed or strength is desirable, psychometric approach to testing could be used as an addition to standard neurological assessment. Muscle strength could be tested with a grip strength dynamometer (7,9) and motor speed with a tapping task (10). However, none of the previous studies have employed a standardized Finger Tapping Test from Halstead-Reitan Neuropsychological Test Battery (8). This is a well established measure with normative data available. Therefore, it can be used not only in group studies with healthy controls, but also in the assessment of individual patients. FTT (1), the objective measure of motor speed, is derived from Halstead-Reitan Neuropsychological Test Battery. The participant presses a button as rapidly as possible for 10 seconds. There are 5 trials for each hand, with 30 seconds intervals between trials and one 60 second interval following the third trial. At first, preferred hand is tested. Mean raw scores are useful in research, while standardized T scores (ranging from 0 to 100, mean=50, SD=10) are used in individual assessment. Performance 2 SD below average (30) indicates impairment. This cut-off score was used in the sensitivity analysis.

MG disability scale (4), a subjective measure of daily function impairment, contains 6 items assessing superior and inferior limb fatigability, swallowing, voice, eyesight and breathing. The scale was chosen due to its high reliability (R=0.95). The global score ranges from 0 to 18, where 18 indicates maximum severity. In the study we used a Polish translation of this scale.

Statistical analysis was performed with two-tailed Student's t-test and one-way ANOVA with *post hoc* Scheffe test for inter-group comparisons. R-Pearson and Kendall (τ)tau-B correlation coefficients were used to determine the relationships between measures used. Pre-established significance level was $p<0.05$.

RESULTS

MG patients exhibited poorer performance in all FTT trials, both for the preferred and non-preferred hand (Table 1). In the MG disability scale the patients averaged 4.53 (SD 3.19).

Although MG patients' performance tended to be lower in the 5th trial than in the 1st trial in case of non-preferred hand, the difference was not statistically significant (Table 2).

FTT mean score for preferred hand correlated significantly with MG disability global score ($r=-0.45$; $p=0.005$) and item 1 referring to superior limb fatigability ($\tau=-0.32$; $P=0.01$) and item 2 referring to inferior limb fatigability ($\tau=-0.39$; $P=0.003$). Similarly, FTT mean score for non-preferred hand showed correlation with the MG overall score ($r=-0.52$; $P=0.001$), items 1 ($\tau=-0.35$; $P=0.008$) and 2 ($\tau=-0.48$; $P=0.0002$). None of the correlations with Oosterhuis score performed with tau-B Kendall correlation coefficient produced significant results.

In one-way ANOVA, used to compare groups of patients with ocular myasthenia, generalized myasthenia and healthy controls tapping mean scores were used. For dominant ($F(2,63)=6.224$; $P=0.003$) as well as for non-dominant hand ($F(2.63)=5.079$; $P=0.009$), only the differences between generalized MG patients and controls were statistically significant in *post hoc* comparisons ($P=0.003$ for dominant hand; $P=0.01$ for non-dominant hand – Scheffe test).

Table 1. Finger Tapping Test results in MG patients and control subjects

FTT and demographic variables		MG patients mean (SD)	Control group mean (SD)	t	P
Age		49 (13)	49 (12)	-0.25	0.80 (n.s.)
Years of education		12 (3)	13 (3)	0.52	0.61 (n.s.)
Preferred hand	trial 1	36.39 (13.44)	44.77 (9.89)	2.96	0.004
	trial 2	35.58 (13.84)	45.52 (8.86)	3.57	0.001
	trial 3	36.76 (13.60)	45.63 (8.77)	3.25	0.002
	trial 4	37.71 (13.26)	46.27 (8.42)	3.23	0.002
	trial 5	38.21 (13.53)	46.38 (8.17)	3.06	0.003
Non-preferred hand	trial 1	36.47 (13.15)	41.33 (6.38)	2.00	0.05
	trial 2	34.84 (13.26)	41.67 (7.73)	2.65	0.01
	trial 3	34.58 (12.34)	39.90 (7.49)	2.20	0.03
	trial 4	34.83 (11.78)	41.43 (7.60)	2.64	0.01
	trial 5	35.00 (12.94)	42.20 (7.15)	2.73	0.008
Preferred hand – mean score		36.93 (12.98)	45.66 (8.35)	3.39	0.001
Non-preferred hand – mean score		35.29 (12.48)	41.31 (6.79)	2.54	0.014

Table 2. Fatigability effect in patients with generalized MG and controls

	MG patients mean (SD)	Control group mean (SD)	t	P
Trial 1 minus trial 5 – right hand	-1.86 (0.91)	-2.00 (6.80)	-0.62	0.95 (n.s.)
Trial 1 minus trial 5 – left hand	1.52 (5.29)	-0.87 (5.17)	-1.75	0.09 (n.s.)

DISCUSSION

FTT results showed its utility in assessing motor performance in MG, as MG patients exhibited slower performance in all 5 consecutive trials for both dominant and non-dominant hand in comparison to healthy controls. The tapping speed was related not only to patients' subjective superior and inferior limb fatigability but also reported disability in daily activities as a whole.

FTT could be a reliable tool in monitoring the disease progress due to availability of normative data and relative insensitivity to practice effect in repeated measurement (11). This strategy was successfully in MG studies adopted with grip strength assessment before and after plasmapheresis (7, 9). The fact that FTT scores could not differentiate between patients with ocular and generalized *myasthenia gravis* is probably due to small subsample size (N=7) in the former group.

In our study FTT did not show fatigability effect when comparing the first with the last trial. Using standardized procedure can show motor slowing in MG, but not the fatigability. This may be due to Halstead-Reitan testing procedure with short tapping trials (10 sec.) and breaks for rest. Modified tapping procedure, such as e.g. the one used in Bartel and Lotz's study (10) with 30 sec. trials, could be more likely to show fatigability effect. Especially, prolonging the tapping trials and suppressing breaks could possibly enhance sensitivity to fatigue effect. Such a procedure could be applied especially in prospective studies when the patient's initial performance serves as reference point instead of normative data (available for standard procedure).

Another advantage of FTT is that it offers a non-invasive, easy and painless testing procedure, so it could be repeated on a regular basis as a functional assessment accompanying subjective and objective measures of motor impairment in MG. Measurement is performed on an interval scale, in contrast to most clinical scales that rate selected aspects of motor performance by means of ordinal scales.

Grip Strength Test and tapping seem to be useful and practical measures in assessing MG patients (7, 9, 10). However, it has not been referred to as such by Keesey (12). FFT could be used in combination with computer analysis of saccadic eye movements to assess oculomotor function (13) as non-invasive and sensitive measures of MG patient's functional status. Whenever possible, methods producing discomfort such as repetitive nerve stimulation or single-fiber electromyography, in spite of their unquestionable utility in diagnosis, should not be overused on a regular basis in the patient's monitoring.

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SUMMARY

The study aimed at showing utility of standardized Finger Tapping Test (FTT) in *myasthenia gravis* (MG) patients and analysing it. FTT data could show not only motor slowness in MG patients but also fatigability effect in standardized testing. FTT provides a wider range of results in terms

of motor performance than the objective scales that are rated by the examiner. 38 MG patients and 30 healthy controls were tested with FTT from Halstead-Reitan Neuropsychological Test Battery. Clinical neurological examination was also performed. MG disability was used to assess the subjective symptoms severity. All FTT trials differentiated the groups. FTT mean scores showed significant correlations with MG disability scale. FTT is a recommended additional functional tool for measuring motor speed in MG as it is both easy to administer and non-invasive.

Test tappingu jako przydatna miara w ocenie sprawności ruchowej pacjentów z miastenią

Celem badania było pokazanie możliwości zastosowania standaryzowanego Testu Tappingu (FTT) w ocenie pacjentów z miastenią (MG) oraz ustalenie, czy test ten oprócz spowolnienia ruchowego jest w stanie pokazać również efekt męczliwości przy standardowej procedurze badania. FTT pozwala na dokładniejszą ocenę sprawności ruchowej niż skale oceniane przez klinicystę. 38 pacjentów z MG oraz 30 zdrowych osób kontrolnych zbadano przy pomocy FTT z Baterii Testów Neuropsychologicznych Halsteada-Reitana. Wykonano również kliniczną ocenę stanu neurologicznego w grupie pacjentów. Skalę oceny niesprawności w miastenii wykorzystano do subiektywnej oceny nasilenia objawów. Wszystkie próby FTT różnicowały między grupami. Średnie wyniki FTT korelowały z wynikami Skali oceny niesprawności dla pacjentów z MG. Zaleca się korzystanie z FTT, który jest testem łatwym w zastosowaniu oraz nieinwazyjnym – jako dodatkowej funkcjonalnej miary tempa motorycznego w MG.