Twenty-four-hour tremor recordings in the evaluation of the treatment of Parkinson’s disease

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Summary. A new method of prolonged recording of EMG provides a good estimate of spontaneous and induced diurnal variations in resting tremor in Parkinson’s disease. It provides a record and a measure of the effects of treatment. Tremor intensity shows considerable variations even over short periods of time. Therefore short-term measurements of tremor are unhelpful. Long-term recordings agree better with the patient’s assessment than with the clinical rating score. Repeated recordings over a similar 10-hour period on 3 consecutive days in one patient showed fairly constant measures of occurrence and intensity of tremor. In contrast to accelerometer measurements of tremor, artefacts caused by movements and general activity of the patient do not materially interfere with tremor evaluation using surface EMG.

Key words. Tremor recording – Parkinson’s disease – Resting tremor – Diurnal variations – Treatment effects

Introduction

Tremor is the cardinal sign of Parkinson’s disease with the greatest fluctuations in severity. It is highly dependent on diurnal variations as well as on circumstantial factors such as emotional embarrassment and stress. These factors influence short-term tremor recordings in the usual laboratory situation as well as the evaluation of the effects of treatment on tremor.

Traditionally, therapeutic effects are evaluated by "subjective" methods such as the self-assessment of the patient (if in an appropriate mental state) or assigned by the physician upon a clinical score. Alternatively, "objective" methods with measurements of tremor frequency, amplitude and waveform have been used. The reliability of these methods is commonly thought to be superior to subjective assessment.

Objective assessment of tremor has usually been performed using accelerometer recordings of tremor for periods of 30–60 s [6, 8, 9, 15]. Evaluation of tremor frequency using spectral analysis is also well established [10]. Tremor amplitude is calculated from the total power content of the averaged Fourier spectra [9]. As tremor frequency is of only minor importance when considering the effects of treatment, the evaluation of tremor in the laboratory is therefore mostly confined to an estimate of tremor amplitude.

To overcome the drawbacks of the short duration of measurement, it has been suggested that methods of tremor assessment should ideally be able to indicate the highest level of tremor that the patient experiences and that provocation methods should be used to explore the full range of tremor in any given circumstance. Changes in the highest level of tremor amplitude are then taken as the basis for the evaluation of treatment [9]. According to the patients’ self-assessments, the maximum level of tremor elicited in these laboratory experiments is equal to or even in excess of the maximum level experienced in daily life [5]. We have followed an entirely different approach in that we felt that the ideal method should be very sensitive, being able to detect even the absence of tremor (zero amplitude), which is the ultimate goal of therapy. We also felt that a representative recording should comprise data over several hours. Finally, we thought it would correspond more to everyday situations and hopefully be more reliable in recording tremor outside the laboratory, preferentially under outpatient conditions. If this were possible then spontaneous diurnal fluctuations in the occurrence and intensity of tremor throughout the whole day could be recorded, and dosage as well as timing of medication could be properly adjusted.

Fluctuations in other forms of tremor, such as essential tremor, are also known to occur throughout the day. They have been recorded with repeated short-term measurements distributed sequentially over several hours, showing the expected marked variability in tremor amplitude [5]. So far only one study has reported long-term recording of resting tremor in Parkinson’s disease, employing an average recording time of 2h [1].

Here we report the first results obtained from an easily applicable long-term recording method using surface EMG and off-line computer evaluation. The technical details of the evaluation have been reported extensively elsewhere [2]. Since the amplitude of the peaks in the spectrum obtained by force recordings and by simultaneous EMG recordings is well correlated, EMG tremor recordings are a possible alternative to accelerometer or force measurements [13]. Examples of clinical applicability to be reported here include results demonstrating the reliability of the procedure obtained in one patient on 3 consecutive days and recordings from two other patients before and after treatment. A comparison of the “objective” tremor data with subjective reports and ratings may help to illustrate both the importance of the method and the weight that should be given to the patients’ self-assessments as opposed to clinical ratings.

Patients and methods

Clinical evaluation. Recordings were obtained from both inpatients and outpatients. In inpatients the first tremor recording
puter and specially designed software [2]. Low-frequency ar-
forearm. Twenty-four hours of EMG data were stored on
sor carpi radialis and flexor carpi ulnaris muscles of each
ration, Dayton, Ohio) was placed 10 cm apart over the exten-
commercially available as 24-h ECG electrodes; NDM Corpo-
analogue tape. Data were processed using a PDP 11/44 com-

restrictions. Self-assessments of treatment effects were elicited
at the beginning of the second recording session.
was clinically assessed by the same investigator at the begin-
was usually performed on the 2nd or 3rd day of hospitalization,
after patients had adapted to their surroundings. In addition
to a complete neurological examination, severity of tremor
can be assessed by the same investigator at the begin-
ning of the recording session (usually at 9 a.m.) for each indi-
and the head using a rating scale (0 = absent, 1 = slight, 2 = moderate, 3 = severe). Patients were asked to
report important events of the day by noting their time and
character in a diary. They were asked not to partake in physi-
correspond to reported sleep intervals or with episodes of
reading or watching TV. With regard to the latter two, one
may suspect that he failed to note short naps in his diary.

The profile of tremor intensity (Fig. 2A, 1–3) from day to
day shows an impressive reliability with minimal and maximal
tremor activity at corresponding times on days 1–3. The percentage
of periods with tremor is also consistent in that the mean value
ranges from 30.9 to 43.7 (Fig. 2C, 1–3). Day 3, the one with
no reported day-time sleep, reveals the largest amount of tre-
mor in several patients on 3 consecutive days each. As an
example, results from one patient are reported here. This 62-
year-old male parkinsonian patient with a 2-year history of
tremor of the right arm and only slight akinesia was studied on
an outpatient basis, since his home was only two blocks away
from the clinic. He received no medication for tremor for any
other disease. Recording started at 9 a.m. on each of 3 con-
secutive days. Electrodes were reattached in the same place
every 24 h. He was instructed to keep to his daily routine but
to refrain from prolonged physical efforts. He kept a meticul-
cious diary noting all of his activities with a temporal resolution
of 5–10 min. Tremor evaluation started at 10 a.m., i.e. the 1st
h of the recording (comprising the journey home and accom-
modation to the apparatus) was discarded. We used an evalua-
tion period of 10 h until 8 p.m. for each recording day. Corre-
ponding times and results are shown in Fig. 2, one beneath
the other, from days 1 to 3. The results are given with a time
resolution of 15.36 s. Periods without tremor (Fig. 2A, 1–3)
correspond to reported sleep intervals or with episodes of
reading or watching TV. With regard to the latter two, one
may suspect that he failed to note short naps in his diary.

Results

Repetition experiment
In order to broaden the data base, to test the usefulness of a
single 24-h recording, and to investigate whether variations of
tremor were regularly locked to the diurnal cycle, we recorded
tremor in several patients on 3 consecutive days each. As an
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mor. The tremor frequency histogram (Fig. 2D, 1–3) exhibits
a peak around 4.2 Hz, with considerable stability in peak fre-
quency and overall comparability of the frequency distributions
across days. This stability even extends to a second broad
frequency band between 6 and 9 Hz. The frequency of the
dominant peak in D shows a range of variation of 1.4 Hz
within any one day (Fig. 2D). The tremor intensity histogram
(Fig. 2E, 1–3) also shows a rather similar distribution on days
1–3, such that no gross changes in overall tremor intensity had
occurred.