J. Neurol. Neurosurg. Psychiat., 1962, **25**, 122

OBSERVATIONS ON ESSENTIAL TREMOR

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Essential tremor, which is also known as familial tremor or, when it appears for the first time in old age, as senile tremor, has attracted interest out of proportion to its incidence or importance as a cause of disability. Critchley, surveying the subject in 1949, was able to provide over 100 references to the literature. This interest stems from the unusual features of the condition. It is not, so far as we know, the result of any disease or injury to the nervous system, but appears in otherwise healthy people, persisting throughout their lives, and being unassociated with other signs or symptoms. One important fact is that, though sporadic cases are by no means rare, there is clearly a strong genetic determinant in the condition. Apart from this last point, hypotheses have tended to exceed facts in the voluminous literature on the subject.

The present study arose during observations on the physiological tremor which accompanies muscular activity in normal people. This tremor, which affects all parts of the body (Marshall and Walsh, 1956), has a frequency of about 10 cycles per second (c/s) in the young adult. In children, however, the common frequency is 5 or 6 c/s, a change to the adult frequency occurring about puberty (Marshall, 1959). From the age of about 40 years onwards the adult frequency declines from 10 c/s to 6 c/s (Marshall, 1961). Since the frequency of physiological tremor varies with age, it is clear that frequency cannot be the sole criterion by which essential tremor may be distinguished. The present study was therefore undertaken to define more closely the features of essential tremor and to clarify its relationship to physiological tremor.

MATERIAL AND METHODS

Thirty patients suffering from essential tremor have been studied. The method of recording the tremor was that described by Marshall and Walsh (1956). Essentially a valve (Mullard DDR 100), which is sensitive to acceleration, is held in the outstretched hand, or attached to the head or foot as the case may be. Any movement of the part gives rise to a signal from the valve which, after suitable amplification, is recorded as a wave form by an ink-writer on a moving strip of paper. The frequency of the tremor was measured by laying a transparent cursor over the recording and counting the number of waves in several samples each of one second's duration.

RESULTS

Most commonly the tremor recorded described a smooth, regular wave form, but in some cases small irregularities disturbed the pattern (Fig. 1). In the case of the upper limb the tremor was usually absent when the limb was at rest and the muscles completely relaxed, but became apparent when muscular activity developed as in the maintenance of a posture. A movement of the limb involving its precise application to a goal, as in the finger-nose test, often caused a terminal exaggeration in the amplitude of the tremor.

When the wave-form was regular it was quite indistinguishable from that seen in Parkinsonism (Fig. 1). The distinction could only be made by

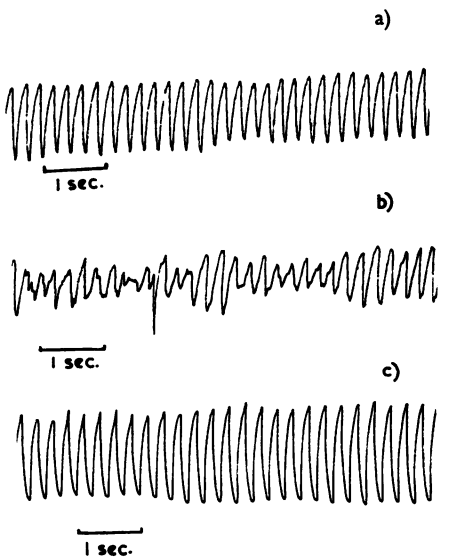

FIG. 1. *A typical recording of essential tremor (a). Sometimes irregularities may disturb the record (b). The regular tremor is indistinguishable from that of Parkinsonism shown in (c).*

noting the presence or absence of other evidence of Parkinsonism, and by the fact that Parkinsonian tremor is usually present at rest and disappears during activity, whereas the opposite obtains in essential tremor. This latter distinguishing feature is, however, by no means invariable. None of the patients in the present series showed any evidence of Parkinsonism.

Though the tremor affected a variety of muscle groups, it was most commonly seen in the upper limbs. In the present series of 30 patients it affected the upper limbs in 29 and the head alone in one. Among the 29 patients with involvement of the upper limbs, there was additional involvement of the head in seven, of the orbicularis oculi in eight, of the tongue in three, of the orbicularis oris in two, of the muscles of articulation in one, and of one lower limb in one.

FREQUENCY OF THE TREMOR It is usually stated that essential tremor, in the upper limbs at least, may vary in frequency from 4 to 12 c/s (Critchley, 1949). In the present series the frequency in the right and left upper limbs was the same in 20 patients, hence each has been counted as a single frequency. In two patients the frequency differed between right and left, hence these have been counted as separate frequencies. Seven patients had only one upper limb affected. There were thus 31 frequencies in the upper limbs for analysis. Plotting these frequencies in the form of a histogram (Fig. 2) shows a bimodal distribution with modes at 10 and 6 c/s.

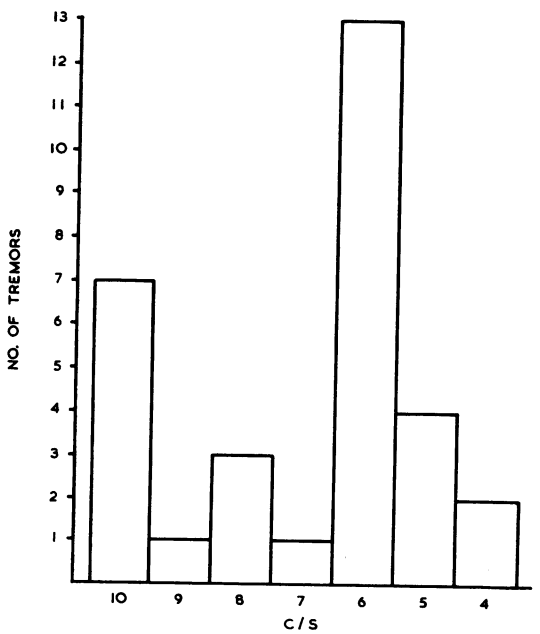

FIG. 2. *Histogram of incidence of tremor frequencies.*

INFLUENCE OF AGE The age at which the patients first noticed the tremor, or had their attention called to it, varied from 6 to 70 years, the distribution being given in Table I. Table II gives the frequency of the tremor in relation to the age of the patient at the time the recording was made and shows that the frequency of tremor tends to decrease with increasing age. It must be borne in mind, however, that the tremor might be of longer duration in the older patients than in the younger. These two factors, age and duration, are themselves correlated, hence it is of interest to see whether each exerts an independent effect on frequency. A multiple regression was calculated, relating frequency to age and duration. The partial regression coefficients, with their standard errors, were as follows:—

Frequency on age (duration constant): —0·050 ± 0·019

Frequency on duration (age constant): —0·001 ± 0·024.

There is thus no evidence that duration has an independent effect on frequency for subjects of a given age. There is, however, a significant decrease of frequency with age, when duration is held constant. Taking limits of twice the standard error on either side of the regression coefficient, it appears that frequency decreases by between 0·1 and 0·9 for each 10 years' increase in age.

TABLE I

AGE AT ONSET OF TREMOR

Years	*5+*	*15+*	*25+*	*35+*	*45+*	*55+*	*65+*	*Unknown*
No. of cases	7	6	2	3	3	2	3	4

TABLE II

MEAN TREMOR FREQUENCY IN UPPER LIMBS IN RELATION TO AGE AT TIME OF RECORDING

Years	*15+*	*25+*	*35+*	*45+*	*55+*	*65+*
No. of tremors	5	7	1	7	5	6
Mean frequency	8·6	7·3	10·0	7·3	6·0	5·5

MODE OF ONSET OF THE TREMOR Seven patients in the series complained of tremor in only one of the upper limbs, nor was any obvious involvement of the other upper limb observed clinically. Recording from the allegedly unaffected upper limb in five of

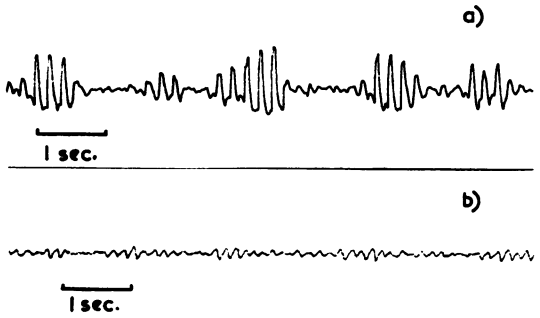

FIG. 3. *Intermittent bursts of high amplitude tremor in clinically unaffected upper limb from two patients.*

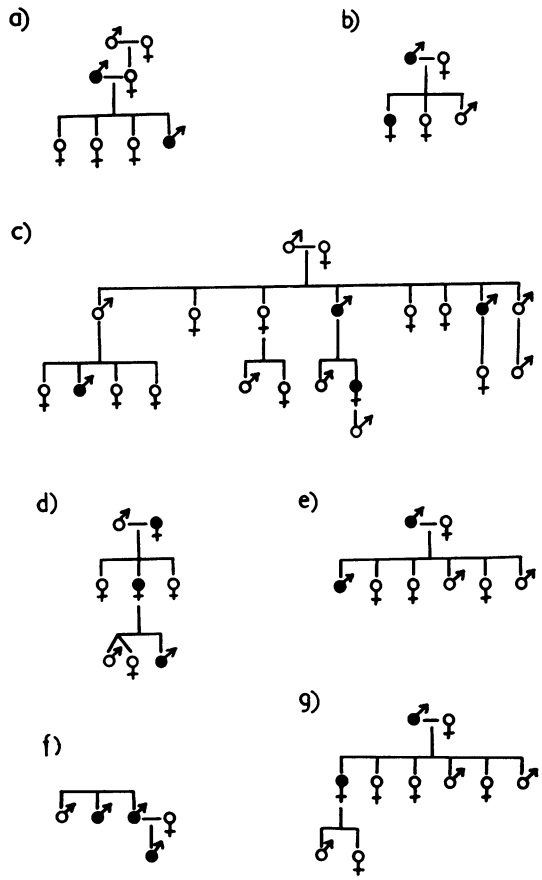

FIG. 4. *Pedigrees of patients with positive family history. Frequency of tremor in patients (a) to (c) was 10 c/s, and in (d) to (g) 6 c/s.*

these patients, however, showed intermittent bursts of tremor of higher amplitude than usual (Fig. 3). There did not appear to be any change in the frequency of the tremor during these bursts, but merely an increase in the amplitude.

GENETICS Seven of the patients gave a history of tremor in other members of the family, but in only one case was it possible to record the tremor in another member of the family. This was a boy aged 16 years whose tremor had first been noticed when he was 8 years. At 16 his tremor had a frequency of 6 c/s. His mother, who accompanied him at the time of recording, had noticed her own tremor from the age of 14 years. She was 47 at the time of recording and her tremor frequency was 8 c/s. The family trees of the seven patients with a positive family history are given in Fig. 4. Three of these (a to c) were from patients whose tremor frequency was 10 c/s.

FACTORS AFFECTING THE TREMOR It was very difficult to assess what factors affected the tremor. All the patients said it was worse when they were embarrassed. Almost every patient said it was worse when drinking tea, but closer questioning revealed that this effect was almost certainly due to embarrassment when the cup shook rather than to any pharmacological effect of caffeine. Alcohol, on the other hand, did appear to have a specific depressant effect on the amplitude of the tremor. The response to cigarette smoking varied; some patients believed it made the tremor worse, others that it made it better.

DISCUSSION

The initial hypothesis which received consideration was that true essential tremor has a frequency of 6 c/s, this being the frequency commonly found in other types of pathological tremor such as that which occurs in Parkinsonism. On this hypothesis the high amplitude tremor at 10 c/s, which had been diagnosed as essential tremor, was dismissed as being due to anxiety. It is well known that anxiety and thyrotoxicosis give rise to an increase in amplitude of the normal 10 c/s tremor (Lazarus and Bell, 1943), and such cases might well be misdiagnosed as suffering from essential tremor if the primary condition was not obvious. There are, however, three objections to this view. First, the patients with the 10 c/s tremor had no other evidence of anxiety or thyrotoxicosis, nor were the circumstances in which the tremor first appeared those commonly found in anxiety states. Secondly, a positive family history of tremor was found in three of the nine patients with tremor frequencies of

9 or 10 c/s and in four of the 21 patients with slower frequencies. Thirdly, the suggestion that a high amplitude tremor at 10 c/s might be an exaggeration of the physiological tremor, whereas a high amplitude 6 c/s tremor must be pathological, was based on the assumption that the frequency of physiological tremor in adults is always 10 c/s. It has been shown that this is not so, but that physiological tremor slows to 6 c/s with increasing age (Marshall, 1961). It is not, therefore, justifiable to label a tremor as pathological merely by reference to its frequency.

A second hypothesis, which has been frequently considered in the literature, is that essential tremor is a monosymptomatic form of paralysis agitans. The evidence for this is scanty, and such associations as have been described could well be coincidental. Critchley (1949) was unable to find any record of the occurrence of more than one case of paralysis agitans in a family with essential tremor. Larsson and Sjögren (1960), in the most thorough population study that has yet been done, though observing some rigidity and stiffness of gait in a proportion of their patients, found no evidence of paralysis agitans nor indeed of any other known neurological disorder. The observation in the present series that in some patients essential tremor occurs at a frequency of 10 c/s is also evidence against any association with paralysis agitans, for in this latter condition the tremor has a frequency of 6 c/s.

The hypothesis which Minor put forward and summarized in 1936, that essential tremor is part of a symptomatic triad of tremor, fecundity, and longevity, has always lacked supporting evidence. Moreover, Larsson and Sjögren (1960), in a careful comparison between the vital statistics of their series and those of the surrounding population, failed to find any evidence of increase in either fecundity or longevity in families with essential tremor.

The observation in the present study that the frequency of essential tremor declines with age suggests that it is basically physiological tremor, but occurs at a higher amplitude than usual. The rate of the tremor, on this hypothesis, is determined by the age of the patient at the time of recording, as it is in physiological tremor (Marshall, 1959, 1961). Thus essential tremor in a person in the first two decades of life should have a frequency of about 6 c/s, in early adult life the frequency should be about 10 c/s, and from about 45 years onwards the frequency should decline to about 6 c/s. This was found to be the case in the present series. Larsson and Sjögren (1960), though not specifically recording the frequency of the tremor, found it to be rapid in the earlier years of the affliction and slower in the later, which may have been a reflection of the age of the subjects rather than the duration of the condition.

The reason why essential tremor, though following physiological tremor as regards frequency, should have a higher amplitude remains obscure. The observation that in the early stages the increase in amplitude occurs in an episodic fashion, against a background of tremor of the same frequency but lower amplitude, suggests that there may normally be a dampening mechanism which becomes impaired. The reason for this impairment is unknown except that it is clearly genetically determined and is not a consequence of any known neurological disease.

The somewhat scanty genetic data obtainable in the present series add little to what is already known about the mode of inheritance of this condition. They are compatible with the view that inheritance is by means of a dominant gene of incomplete penetrance, though no doubt the incidence of tremor in the relatives might well have been found to be higher had it been possible to examine them, as was clearly demonstrated by Jager and King (1955). The genetic data did, however, help to refute the hypothesis that the patients with a tremor of 10 c/s were suffering from anxiety states.

SUMMARY

The frequency of essential tremor has been recorded in 30 patients and found to decline with age, as does the frequency of physiological tremor. It is suggested that essential tremor is basically physiological tremor but occurs at increased amplitude because of some unknown, but genetically determined, deficit in the nervous system.

I wish to thank Professor P. Armitage for the statistical analysis and the Central Research Fund of the University of London for a grant towards apparatus.

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