

# Semiology Of Tremors

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(Exordium)

*"Binas has tremoris species. Primam, quando quiescenti homini involuntariis illis et alternis motibus agitantur membra, palpitationem (πάλλωσις) dixit, posteriorum vero, quae non fit nisi homo conetur partes quasdam movere tremorem (τρόμος) vocabit"*

(Galen, 2nd century A.D.)

**SUMMARY:** *Since the description by Galen in the 2nd Century, A.D., clinical neurology has acknowledged the existence of two types of tremor: that which occurs at rest and that occurring during the execution of movement. With the help of refined methods of analysis, E.M.G. and cinéphotography, the authors have carried out a detailed clinical assessment in more than 400 patients.*

*The basic criterion used to define a tremor was the classical definition of Dejerine: "An involuntary, rhythmical and symmetrical movement about an axis of equilibrium."*

*As a result of this study, the conclusion has been reached that there are two types of tremor: postural tremor and tremor of attitude. Both are present*

**RÉSUMÉ:** *Depuis la description de Galien au II<sup>ème</sup> siècle, la neurologie reconnaît l'existence de 2 sortes de tremblement: de repos et d'action. Les auteurs rapportent une étude clinique détaillée faite de plus de quatre cents patients affectés d'un tremblement de sémiologie variée en utilisant des techniques d'analyse plus raffinées: électromyographie et cinéphotographie.*

*Pour identifier un véritable tremblement, nous avons adopté comme critère formel la définition de Déjerine: "un mouvement involontaire, rythmique et symétrique autour de l'axe d'équilibre du membre." Cette étude a démontré que le véritable tremblement ne se manifeste que lorsque le malade veut maintenir immobile le membre qui tremble; soit en l'abandonnant à la force de la gravité: c'est le tremblement postural;*

*while the limb remains immobile, whether by wilful design or when at rest in a position of posture and subject only to the action of gravity.*

*During voluntary movement, tremor is not present. Irregular, asymmetrical and non-rhythmic oscillations may appear however — as in so-called intention tremor, of cerebellar origin — but this abnormal movement can hardly be called a real tremor. It is merely a manifestation of ataxia.*

*As a consequence of this study, it is suggested that further understanding of the basic mechanism of tremor can be reached by the investigation of the central neural structures which are involved in the physiology of posture and attitude.*

*soit en essayant de le maintenir dans une position déterminée à l'encontre de la gravité: c'est le tremblement d'attitude.*

*Par contre, pendant l'exécution d'un mouvement volontaire, il peut y avoir une incoordination du mouvement, une erreur dans la direction de la trajectoire ou dans la mesure de la distance dont l'exagération peut donner une apparence oscillatoire au mouvement, mais ce phénomène, appelé couramment tremblement intentionnel ou d'action, n'est pas un véritable tremblement.*

*De ce fait, une meilleure compréhension des mécanismes neurophysiologiques du tremblement pourrait être acquise en étudiant plus spécifiquement les structures nerveuses qui contrôlent les mécanismes de la posture et de l'attitude.*

## INTRODUCTION

Of the involuntary movements in man, tremor is the most frequent. However, in spite of numerous publications devoted to the study of this phenomenon, its neurophysiological mechanisms are far from understood. The study of the subject appears to be impeded by a fundamental error of methodology: namely a superficial analysis of the symptom. This has come about by ambiguity of definition, errors of diagnosis, and several confusing classifications which render clinico-anatomical correlation difficult.

In the study of diseases of the nervous system in man, it is of paramount importance to establish the semiology of a given disease entity. This consists of a precise definition and analysis of symptoms. This first step constitutes a fundamental method of research which is indispensable and cannot be neglected or supplanted by modern technical methods.

## AN HISTORICAL SURVEY

The most ancient classification of tremor dates to the time of Galen in the second century. He distinguished two types. The first he called "palpitatio" consisting of involuntary alternating movements and appearing in the extremities during rest. The second was referred to as "tremor" which manifested itself during voluntary movement of a part of the body.

Sylvius de la Boe, in the seventeenth century, retained the same

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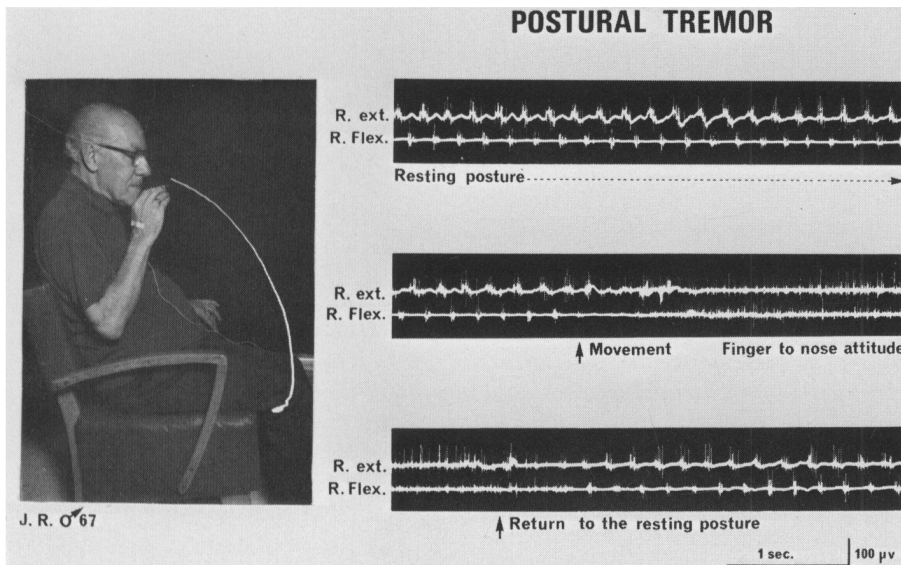


Figure 1 — Analysis of postural tremor in a Parkinsonian patient. In this and all of the following illustrations, the upper line of the E.M.G. tracing corresponds to the extensor digitorum communis and the lower line to the flexor digitorum profundus.

The tremor consists of rhythmic and alternating activity, while the hand is at rest, and disappears at the commencement of movement and during the maintenance of the attitude whereby the patient attempts to fix a finger on his nose. It reappears when the hand is brought back to a resting position while the arm is being supported by the chair rest.

descriptions, but changed the terms employed by Galen. He called "tremor coactus" that which Galen had referred to as "palpitatio" and stated that it occurred independent of movement and only appeared when the member was at rest. Galen's "tremor" called "motu tremulo" by de la Boe appeared only when the patient tried to execute a movement and disappeared when he was at rest.

In 1817, James Parkinson in his classic study entitled "Essay on the Shaking Palsy" described tremor in the following manner: "Involuntary tremulous motion, with lessened voluntary muscular power in part, not in action, and even supported". This is merely a more precise definition of "tremor coactus" of de la Boe and the "palpitatio" of Galen.

Subsequently, the above classical distinction has remained and continues to be thought of as the difference between the two types of tremor. In accordance with language and the subtleties therein, different authors have added definitions and variations in terminology (Charcot,

1887; De Jong, 1967; Marshall, 1968).

The first systematic classification of tremor by a French neurologist was that of Charcot (1887) who also distinguished two kinds of tremor. First, that which appeared during movement and was called "intention tremor", corresponding to "tremor" or "motu tremulo" of Galen and de la Boe respectively. The second encompassed all the other forms and was classified as "tremor of rest", which corresponded to Galen's "palpitatio" and de la Boe's "tremor coactus". Thus Charcot's classification was not different from the English authors and conformed with those described by the ancient authors.

In 1928 Andre Thomas described a peculiar circumstance during which a tremor was manifested throughout the maintenance of a given attitude. This concept has recently been fostered by Bonduelle (1952) and Rondot (1968) but the neurological literature remains in a state of some confusion because of the notion of intention tremor.

Dejerine in his treatise "Semiologie du systeme nerveux" (1902) dedicated an entire chapter to the problem of tremor. He was the first to establish a definition of capital importance "Les tremblements sont caractérisés par des oscillations rythmiques, involontaires, que décrit tout ou partie du corps autour de sa portion d'équilibre", which translated states that tremor is characterized by involuntary, rhythmic, oscillations about an axis of body equilibrium. He stated that tremor is distinct from other involuntary movements such as chorea, myoclonus, tics and ataxia by virtue of being a rhythmic oscillation about an axis. Throughout this work the definition of Dejerine has been used to distinguish tremor from all other involuntary movements.

#### MATERIAL

This paper is the study of about 400 patients affected by involuntary movements which at first were thought to be tremor. The majority of these were Parkinsonians. About a fifth suffered with essential or heredo-familial tremor. In the remaining cases, whether a tremor existed or merely an involuntary movement resembling tremor, this manifestation was one of the symptoms of the various illnesses studied. One such group of patients manifested a congenital or an acquired complex dyskinesia; another belonged to that group of illnesses referred to as endocrine-metabolic disorders and finally a last group was categorized as "functional" disorders of which two suffered from conversion hysteria.

#### METHOD

Three methods of analysis were utilized; direct visual observation, cineradiography and electromyography. The first method permitted us to define the clinical circumstances of the tremor. The second method allowed us to obtain an objective photographic record of the amplitude, trajectory and the circumstance of the tremor. A similar method of light-line photography was employed by Holmes (1939) for the study of disturbances in rate of

movement. The E.M.G. provided a detailed recording of the frequency and amplitude of the muscular activity of the tremor. An accelerometer was also employed but the trace obtained with it gave less information than the E.M.G. For this reason it was thought to be superfluous to our study.

#### DESCRIPTION OF THE SEMIOLOGY OF TREMOR POSTURAL TREMOR

Postural tremor appears while the limbs are relaxed with arms alongside the body while reclining, or hanging passively while sitting or walking. In these circumstances, the most important factor from the neurophysiological point of view is the absence of voluntary action. The execution of a voluntary movement, no matter how insignificant, is usually sufficient to stop the tremor. Neglect of this simple observation is the origin of the commonly held notion that tremor persists during movement. For example, tremor of the wrist and fingers persists in repetitive flexion of the arm at the elbow. It is evident that the muscles which flex the elbow are not the same as those which govern movements of the wrist and fingers, which are the immediate effectors of the distal tremor. The latter is therefore, not affected by movements of the shoulder or the elbow. Even the muscular tension which results from fixing attention on the tremulous limb is usually sufficient in most cases to interrupt, at least momentarily, the tremor. It is also apparent that practically any circumstance favoring relaxation of the affected extremity enhances the tremor.

Postural tremor is one of the symptoms of the Parkinsonian syndrome and it is rare to find true postural tremor other than in cases of Parkinson's Disease. Without involving ourselves in a discussion of the different clinical forms of Parkinson's Disease, we can summarize the various aspects of postural tremor by studying it as it appears throughout the evolution of the disease. At the onset, the tremor appears only during fatigue or emotional upset and consists of muscular

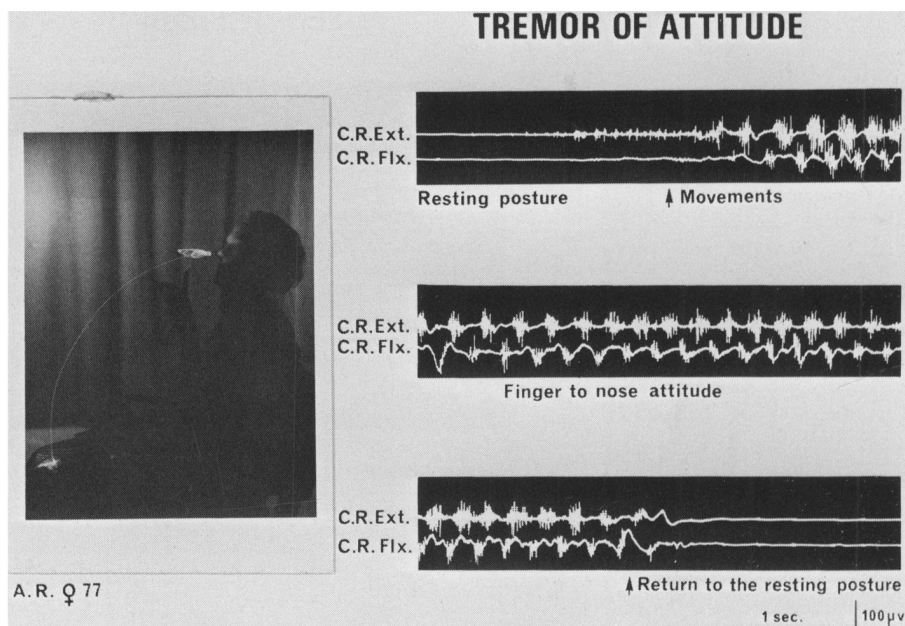


Figure 2 — In this illustration tremor of attitude is analyzed. Although absent at rest, the irregular muscular discharges which appear throughout the movement of the elevating arm become rhythmical while the hand is being maintained immobile in an attitude with the finger pointing toward the nose.

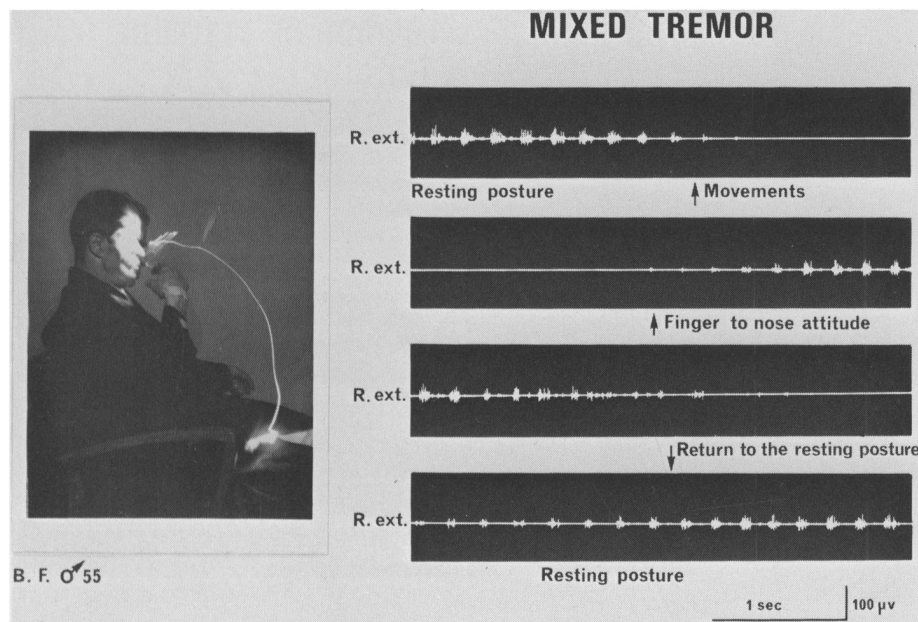
contractions which are more or less rhythmic, rapid and inconstant. The amplitude remains small and the tremor resembles a physiological tremor or shivering. At this early stage of the disease it may be difficult to ascertain the diagnosis. Later the tremor becomes more evident, the contractions assume a greater amplitude, the rhythm becomes slower and more regular and if the patient maintains a relaxed posture, the tremor will persist. Moreover, electromyography or simple muscle palpation demonstrates the alternat- ing character of the tremor.

Postural tremor of Parkinson's Disease has a frequency which varies from subject to subject and also from extremity to extremity, and from muscle group to muscle group and from moment to moment in the same muscle of the same limb. In the group which we have studied, the greatest rhythmic variation found between patients was 4.2 c/s (the slowest frequency being 3.8 c/s and the fastest 8 c/s). The greatest difference between two limbs in the same patient was 1.8 c/s (4 and 5.8 c/s). One muscle group displayed a difference of 1.5 c/s (4.1 to 5.6 c/s) during the same recording.

Save for rare exceptions, the lowest frequency tremor was seen in patients with long-standing illness when observed in a state of complete relaxation. It was also invariably observed that the slower the frequency, the greater the amplitude. The greater the tremor frequency, the longer the time required for the patient to commence manifesting tremor. Mental tension provokes excessive muscular tension and consequently augments the frequency of the tremor while diminishing the amplitude.

Figure 1 demonstrates the cinephotographic and electromyographic characteristics of a Parkinsonian patient.

When confronted by an advanced case of Parkinson's disease one may have the impression that the tremor is mixed, at times postural and at times kinetic. The rigidity may be sufficiently marked that the hand and forearm remain fixed in the original posture during movement at the proximal joints. In these cases it suffices to ask the patient to move his fingers to abolish the tremor. Similarly, while executing the movement of bringing an index finger close to the nose, the patient's



**Figure 3** — An example of mixed tremor present when the extremity is relaxed and at rest and also present while the pointing finger is directed to the tip of the nose and maintained in this attitude. The tremor disappears during the execution of repetitive movements.

tremor disappears but once the goal has been attained and maintained, the tremor reappears. The same phenomenon has occurred: in this case, and because of the proximal rigidity, the voluntary attitude of the hands becomes, after a few seconds, a relaxed posture. It is only necessary to ask the patient to replace his fingers properly in front of his nose and the tremor disappears.

As the illness progresses to the later stages, one witnesses the gradual disorganization of the tremor. It diminishes in amplitude and regularity and in many cases disappears. In short, the patient becomes akinetic and in the process the inverse relationship between tremor and akinesia appears.

Postural tremor is also present in the lower extremities of Parkinsonian patients and presents the same characteristics as in the upper extremities, although the rhythm is generally slower (3-5 c/s). When the tremor of the head is present, it is most often of the affirmative type, characterized by alternating contraction of the neck flexors and extensors. As the illness advances, the tremor diminishes or disappears, possibly due to hypertonia of the

flexors maintaining the head in a permanently flexed and rigid posture. Occasionally rhythmical and asymmetrical muscular contractions persist, but these are usually insufficient to displace the head. When the mouth, tongue and pharynx are affected by tremor, the speech becomes repetitious as the patient repeats words or syllables. This phenomenon is referred to as palilalia.

#### TREMOR OF ATTITUDE

The conditions for the appearance of tremor of attitude are almost diametrically opposed to those of postural tremor. Tremor of attitude is absent when the extremities are being supported or are hanging passively at rest while standing or walking. It manifests itself only while the patient consciously maintains an attitude against the force of gravity and when this attitude is directed toward a precise goal, (Fig. 2), and it continues as long as the attitude is maintained. Moreover, the more complex the attitude, the greater the intensity of the tremor, as for example in the holding of a glass near the lips or when the patient is impeded from sustaining a definite attitude. The most important neurophysiolog-

ical consideration is the associated increase in voluntary motor action in carrying out a specific attitudinal objective. The tremor of attitude is distinguished from postural tremor in that the latter appears without voluntary action. However, postural and attitudinal tremor are similar in that neither appears during phasic movement (Fig. 5). One may say that both, in a sense, are static tremors.

The description given above is of tremor of attitude of the upper extremity, which is the most frequent site. In a series of 43 patients, (a separate study), 42 patients (97%) experienced tremor of the upper extremities, 17 (40%) experienced tremor of the head, 7 (16%) displayed tremor in the lower extremities, 4 (9%) and 2 (5%) manifested tremor of the tongue and abdominal wall respectively. Only one patient displayed tremor of attitude of the eyes. Four patients showed tremor only in the head.

It is important to differentiate tremor of attitude of the head from postural tremor of the head and also from ataxia of the trunk secondary to cerebellar lesions. The following are criteria used in differentiating the etiology of the tremor.

Tremor of attitude of the head is absent when the head is supported and the muscles of the neck are relaxed. It is apparent that the amplitude of the tremor is directly proportional to the extent of voluntary muscle activity and one can see the progressive increase of the tremor as the patient lifts himself from his bed. The tremor may be increased if the examiner, holding the patient's head to impede rotation, asks the subject to turn his head. These characteristics are unlike those seen in postural tremor.

The second characteristic, which in our experience is always present, is that attitude tremor of the head is of the negative type, whereas postural tremor is of the affirmative type. This is because postural tremor is a function of the pro and anti-gravity muscles, while tremor of attitude affects the muscles used in turning the head to the side.

The commonest type of attitudinal tremor is probably essential or heredo-familial tremor (Critchley, 1949; Minor, 1930). However, this is not the only form. Tremor of attitude is also associated with any of the diseases collectively referred to as "pathology of attitude" i.e., it may be present in dystonia of an isolated limb, dystonia musculorum deformans, spasmodic torticollis, athetosis. Tremor of attitude is also seen with cerebral tumors involving the striatum (Molina and al. 1974).

A true tremor of attitude is also seen in some patients with multiple sclerosis, but this is infrequent. In most cases the tremor is referred to as an intention tremor secondary to cerebellar disease. Some observers believe there is a relationship between tremor of attitude seen in heredo-familial tremor and the intention tremor of cerebellar disease. We think there are distinct differences between these two disorders for the following reasons:

a) We have never observed signs of cerebellar disease in patients suffering with heredo-familial tremor of attitude (Hardy et al., 1970).

b) Patients with multiple sclerosis and a true attitude tremor have been seen. However, they have shown no signs or symptoms attributable to cerebellar disease.

It is known that alcoholics present with tremor. These patients, however, also show movements which although involuntary in nature, must be distinguished from tremor. Thus chronic alcoholics in a period of abstinence show what may be referred to as "distal shaking" of the extremities which disappears with the intake of alcohol. This represents an exaggeration of physiological tremor. However, when alcoholic intoxication produces parenchymatous liver disease one can observe a tremor characteristic of tremor of attitude. By the alternating and rhythmic nature of this tremor plus other signs, one can infer the existence of associated cerebral disease and classify this tremor among the group of symptoms referred to as hepatic encephalopathy. Finally, in prehepatic coma, one may see a

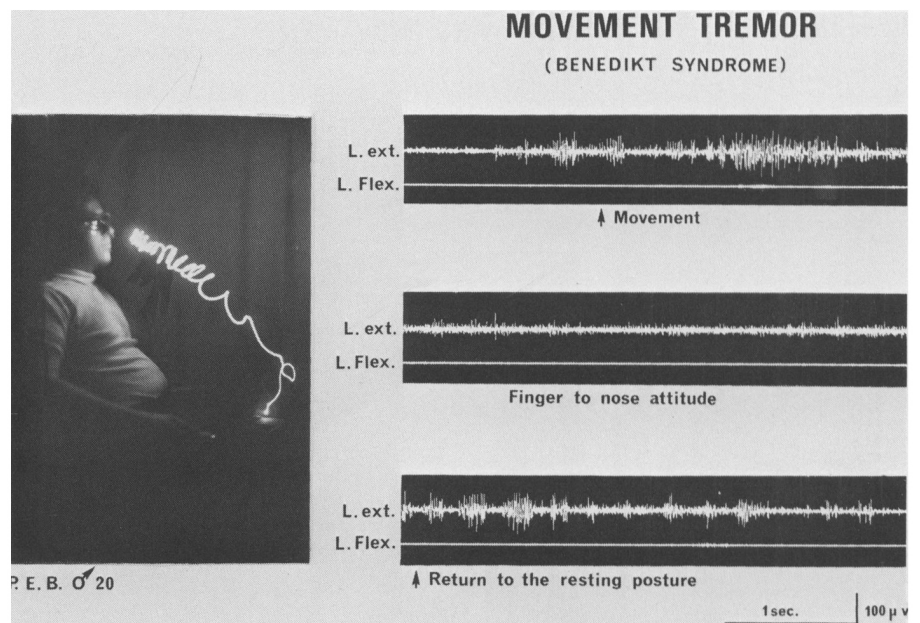


Figure 4 — The analysis of movement tremor in a patient who manifested a post-traumatic Benedikt's syndrome. During a trajectory directed toward the nose, non-rhythmic muscular contractions localized chiefly in the extensors are present. These correspond with the asymmetrical oscillations of the luminous trace.

flapping tremor or asterixis. It appears when the patient extends his hands in front of him and spreads his fingers. The flapping consists of a brisk dropping of the wrist, due to sudden failure of the normally sustained extension of the wrist, followed by an immediate correction. This tremor is absent during voluntary movement and does not appear when the hands are at rest.

#### MIXED TREMOR

A mixed tremor which has both postural and attitudinal characteristics is rarely encountered. With this combination the tremor manifests itself while the patient is at rest standing, sitting or reclining. It is also present whenever the patient assumes an attitude requiring wilful maintenance. However, the tremor disappears throughout the execution of purposeful movements. Two patients have been seen with such a mixture (Fig. 3). The tremor of these patients had evolved over a period of several years without rigidity, bradykinesia, dystonia, or other symptoms. A precise diagnosis was not made. Both patients responded well to surgery in that both the unilateral attitudinal and postural com-

ponents were abolished simultaneously by one contra-lateral thalamic lesion.

#### MOVEMENT TREMOR

The elaboration of the terminology "tremor" and "motu tremulo" by Galen and de la Boe respectively implies that both these authors were aware of the essential nature of this kind of tremor and their descriptions will always remain valid. Galen wrote: "Two kinds of tremor exist: the first appears while the patient is at rest and consists of involuntary, alternating oscillations of the extremities, and is called 'palpitatio'; the second appears only while that individual attempts to move a body part and is called 'tremor'." The distinction made by Galen established an important notion: kinetic tremor was not produced by the so-called "palpitatio" of muscles but was due to the articular displacements which decompose the movement into irregular shaking excursions. One might argue that every articular displacement is due to a muscular contraction and conversely that every muscular contraction engenders the displacement of an articulation. This is not always the case. One may

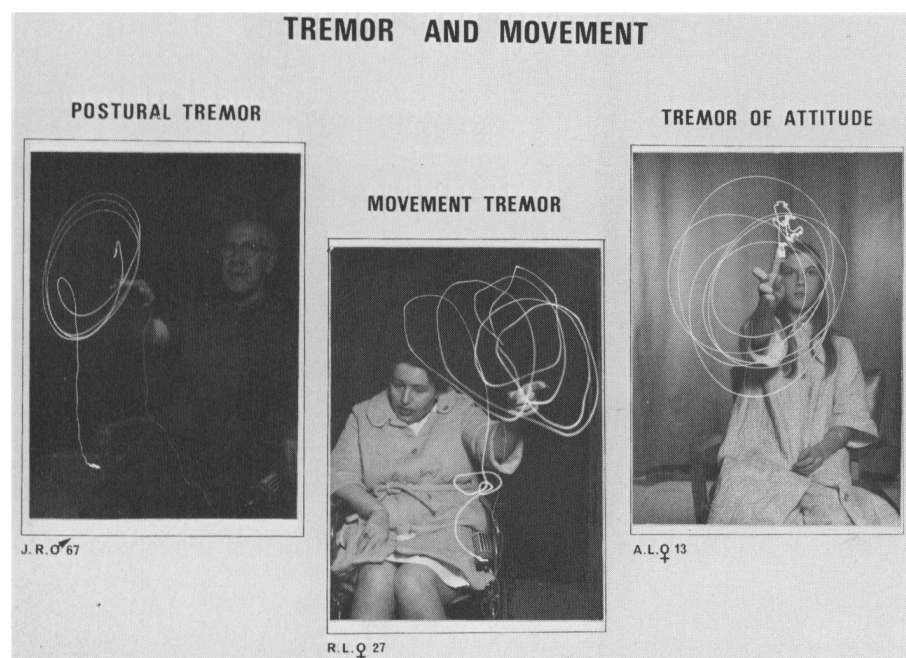


Figure 5 — Cinematographic illustration of both types of tremor, postural and attitudinal, which disappear during circling movements. Conversely, movement producing an irregular trajectory is seen in a patient with a left dentate astrocytoma.

observe the isolated contraction of a muscle or a part of it without articular displacement and it is the latter which we see with Parkinsonian patients. E.M.G. recordings show rhythmic muscular discharges ("palpitatio" of Galen) without the tremor. However, so-called kinetic tremor, while absent without movement, is more apparent whenever the extremity is made to execute bigger movements, due to the coming into play of the greater articulations. This fundamental characteristic is well described by de la Boe who called it movement tremor ("motu tremulo"). The analysis of E.M.G. recording and cinematography has demonstrated that kinetic tremor is characterized by intermittent, irregular, non-rhythmic contractions and manifests itself to a greater degree in those muscle groups most directly involved in the voluntary motor control of a movement. It is also apparent that the closer the movement comes to completion, the more violent is the tremor. The tremor ceases once the movement has been completed. On the other hand, if the examiner supports the patient's extremity while

he executes the movement, the tremor does not appear and the movement is completed without error. Finally, automatic movements such as swinging the arms while walking are completely without evidence of tremor. Thus the kinetic tremor is not a true tremor since it is neither rhythmic or symmetrical and is not present about a body axis of equilibrium. Figure 4 illustrates this type of tremor in a patient with a post-traumatic Benedikt's syndrome.

It is thought that the cerebellum controls the harmony of voluntary movement by coordinating muscular agonists and antagonists, and by judgement of distance, so that precise movement can be achieved. Disturbance of these mechanisms by a cerebellar lesion produces dysmetria, incoordination and ataxia. The exaggeration of these abnormalities is represented by the kinetic tremor (Fig. 5). This tremor is less apparent in diseases of cerebellar afferents. With the spino-cerebellar degenerations and tumors of the hemisphere one rarely sees kinetic tremor but merely a moderate degree of ataxia. On the other hand, lesions of the superior mesencephalon which

compromise the cerebellar efferents produce involuntary oscillations. These become more violent as the end of the movement is approached and can be easily confused with a true tremor. Photographic and E.M.G. analysis demonstrate that it is no more than a particularly violent, non-rhythmical and asymmetrical ataxia.

Finally, the movement disturbance referred to as kinetic tremor is fundamentally a deficit phenomenon of the cerebellum, as evidenced by its constant association with hypotonus. In addition, it is associated with pendular reflexes resulting from muscular hypotonia. This is best seen in the antigraivty muscles which are the antagonists of those involved in phasic, voluntary, motor activity. This mechanism is distinct from the fundamental facilitating mechanisms which are liberated in the manifestation of a truly rhythmic tremor such as a tremor of attitude. Consequently, if one discovers an alternating, rhythmic movement (a facilitating entity) together with the presence of a true cerebellar syndrome (which is deficitory in nature), it is necessary to look for an additional lesion outside the cerebellum since it is not the nature of cerebellar disease to produce a true tremor.

#### VIBRATORY TREMBLING OF THE EXTREMITIES

There are many diseases which manifest themselves by tremor. Patients with anxiety and insomnia, or in a state of permanent psychic tension are often tremulous. The same phenomenon may be temporarily present in normal individuals under emotional stress or following strenuous physical effort. Tremor is also seen in febrile illness, after prolonged exposure to cold and during an anaphylactic reaction. Once equilibrium has been re-established the tremor disappears. However, in patients suffering from alcoholism, drug intoxication and endocrine disorders it may prevail. Charcot described the latter phenomenon as "vibratory tremor" and attributed to it the characteristics of a fine, rapid (8-9 c/s) movement of the ex-

tremities. Figure 6 illustrates a tremor of a patient with untreated thyrotoxicosis. The tremor was not seen during rapidly executed movement but was present when the limb movement was carried out at slower speeds. When the patient was completely relaxed there was no evidence of tremor. The tremor was apparent whenever there was the slightest voluntary muscle activity and it persisted as long as the latter continued. The oscillations were rapid (8 c/s), irregular, and small in amplitude and were not associated with alternating muscle agonist and antagonistic contraction. After a few days of treatment the tremor diminished along with the other symptoms of hyperthyroidism and after a week the tremor was completely absent.

#### CONCLUSION

Since we have adopted the definition of Dejerine as our formal criterion in the identification of tremor, the following classification is proposed:

##### *Classification of oscillatory movements*

#### A. Tremor

1. Postural
2. Attitudinal
3. Mixed (postural and attitudinal)

#### B. Movement tremor (Intention or Kinetic)

#### C. Vibratory trembling (Physiological tremor, normal or exaggerated)

It is thought that true tremor appears in two situations. The first is called postural where a patient allows a limb to remain passively under the influence of gravity and the second is called attitudinal where the patient attempts actively to maintain a predetermined position and wilfully counters the force of gravity. On the other hand, it is possible to observe incoordination during the execution of a movement which results from trajectory error or from incorrect judgement of distance. The latter faults may then result in an oscillatory-like or exaggerated movement currently referred to as an intention tremor or action tremor which we believe is not a true

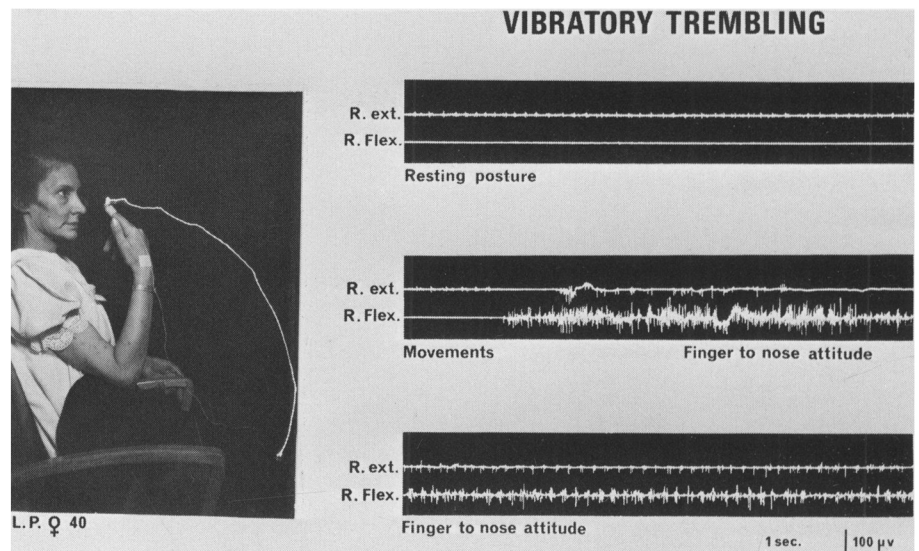


Figure 6 — Analysis of vibratory tremor in a patient with untreated thyrotoxicosis. The muscular discharges are fine and rapid (8 to 10 c/s) and are present throughout all of the clinical examination and become totally disorganized during the execution of movement; on close scrutiny, these discharges resemble the normal vibration seen in physiologic tremor.

example of tremor. This distinction is not merely a matter of semantics, but one of necessity, since all of the preceding discussion hinges on accurate clinical-anatomic correlation. It is our conviction that more effective attempts to comprehend the functional mechanism of tremor will result from the study of those particular nervous structures controlling posture and attitude.

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