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A Review on Techniques for Tremor Recording and Quantification

Paulo Henrique G. Mansur,* Lacordaire Kemel P. Cury, Adriano O. Andrade, Adriano A. Pereira, Guilherme Alessandri A. Miotto, Alcimar B. Soares, Eduardo L. M. Naves

Federal University of Uberlandia, Faculty of Electrical Engineering, Laboratory of Biomedical Engineering, Uberlandia, Brazil

*Address all correspondence to Paulo Henrique G. Mansur, Rua Manoel Gonçalves de Araújo, n. 51, Centro, Pires do Rio (Go), CEP: 75.200-000, Brasil; paulomansur@yahoo.com.br.

ABSTRACT: Tremor is the most common movement disorder and differs from other disorders by its repetitive, stereotyped movements, with regular frequency and amplitude. The three most frequent pathological forms of it are the essential tremor (ET), the Parkinson's disease (PD) tremor, and the enhanced physiological tremor. The ET and PD tremor affect the older population mostly. Although there are cases of tremor reported since ancient times, there is currently no consensus about its causes or about its main differential characteristics. In this article, we present a review of the methods more frequently used in measurement and analysis of tremor and the difficulties encountered in the research for the identification of methodologies that allow a significant advance in the study of tremor.

KEYWORDS: tremor, essential tremor, Parkinson's disease, enhanced physiological tremor

I. INTRODUCTION

Tremor is the most common disturbance of movement, and it is defined as a rhythmic and involuntary oscillation of a body part, caused by reciprocal innervations of a muscle, which leads to repetitive contractions.[1–4] It can vary in frequency and amplitude and is influenced by motor, physiological, or psychological factors and by the consumption of drugs and other chemical substances.[2]

The tremor differs from other involuntary movement disturbances, such as chorea, athetosis, and ballism, by its repetitive and stereotyped movements, with regular frequency and amplitude.[4]

There are different kinds of tremor with a variation of patterns and progression degrees.[1] The cases more commonly encountered in clinical practice are the essential tremor, the Parkinson's disease tremor, and the enhanced physiological tremor.

The study of the tremor is not recent. There are descriptions in

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biblical texts and in ancient documents from India and Egypt of symptoms similar to the ones found in Parkinson's disease.[5]

Galeno from Pergamo (second century B.C.) related, in his text named *De Tremore*, that the cause of the tremor was the reduction of the forces that support the body. Static tremor was named *palpitation* and was attributed to a collapse of the heart or arteries. Between the sixteenth and eighteenth centuries, German physicians refined the theories of Galeno. In that period, studies were made that permitted the distinction between the static tremor and the tremor in action, which had already been related by Galeno, especially the works of Junker (1679–1759), Boissier De La Croix Sauvages (1706–1767), and Sylvius de la Boe (1614–1672). Parkinson, incidentally, cited the latter in his work.[6]

In the nineteenth century, the term *essential* was used for several diseases that did not seem to have medical causes. The first work with detailed descriptions of the essential tremor was written by Charles Dana, a North American neurologist, who documented, in 1887, the presence of that kind of tremor in several families of New York. The term *essential tremor*, nevertheless, only began to be used with some consistency in medicine as of the middle of the twentieth century to name a kinetic kind of tremor, usually with familial origin and without a definite cause.[7]

In 1817, English doctor James Parkinson published the first well-defined description of the disease named after him, in an article titled "An Essay on the Shaking Palsy."[8] In his work, Parkinson related six cases he had encountered by chance in the street. He made considerations about the disease's symptoms, its differential diagnosis, and about its possible etiology and treatment, naming the disease "shaking Palsy." Later on, other authors became interested in the disease, including neurologist Jean-Martin Charcot, who had the opportunity to study it more thoroughly in cases of the Hospital La Salpêtrière in Paris at the end of the nineteenth century.[8]

During the twentieth and twenty-first centuries, the quantification of the tremor was the object of study of several researchers.[9–12] This quantification allows the tremor to be studied in an objective way; that is to say, parameters extracted from the tremor activity can be related with variables such as age and the presence of neurological diseases.

The quantification of tremor involves the selection of sensors for its detection and the use of tools for digital signal processing that permit the extraction of its characteristics. Presently, there is no standard for the use of analysis methods and the detection of tremor.

In the literature, it is possible to find countless strategies with that objective. Therefore, this article proposes a critical review of the current state of the art in studies involving tremor.

II. CLASSIFICATION

There are two systems of classification for tremor. The first is based on its form of occurrence (static or in action). The second is based on its causes (physiological or pathological).[2,4]

The static tremor occurs when the affected part is relaxed, still, and totally supported by gravity and the muscles are not voluntarily actuating.[2] This tremor usually disappears when a movement or action begins.[1] For that reason, in most cases in which the static tremor is the main symptom, there are no large problems for the patient, except for embarrassment.[4]

The action tremor occurs during a voluntary muscular contraction. It is divided into postural, isometric, and kinetic types of tremor.[1,4] Some authors classify the task-specific tremor and intentional tremor as types of action tremor.[2,13] Others include those two kinds of tremors as subdivisions of the kinetic tremor.[3]

The postural tremor occurs when the affected part is kept in a position contrary to the action of gravity. The isometric tremor occurs when there is a muscular contraction against a stationary object. The kinetic tremor, on the other hand, occurs only during the accomplishment of any action with the affected limb.[2]

The task-specific tremor occurs during the accomplishment of a certain task such as writing or playing a musical instrument.[2] Some authors do not consider the task-specific tremor as an isolated kind of tremor but as a variation of the essential tremor. Other authors believe that it is characteristic of a local type of dystonia.[4]

On the other hand, the intentional tremor is the one that increases intensity when the person approaches a certain target he or she wants to reach, under visual observation.[2,3] The intentional tremor is caused by lesions of the cerebellum and can sometimes be confused with myoclonia.[4]

III. TREMOR CHARACTERISTICS

The physiological tremor is normal and happens in all healthy human beings. Its signs are so subtle that they can be hardly perceived with the naked eye. The physiological tremor only becomes more visible in situations such as stress, muscular fatigue, anxiety,

fright, or excitement, and it can increase with the use of chemical substances, as occurs in alcohol intoxication.[4] Most of these factors increase the sympathetic activity.[1] One of the main characteristics that distinguishes the physiological tremor from other diseases is that when the cause stops, the tremor stops as well.

Parkinson's disease is a complex syndrome that consists of tremor, rigidity, bradykinesia (slowness of movement), and posture instability. In approximately half the patients, tremor is the main visible symptom, although 10% of the carriers do not present tremor.[2] Studies suggest that doctors do not diagnose up to 10% of Parkinson's patients until the symptoms become more severe.[14]

The tremor in Parkinson's disease happens characteristically in the static position, but there are forms in which it appears in the posture and may then be confused with essential tremor.[2,15] Bhidayasiri[16] relates that up to 40% of Parkinson's patients present mixed forms of tremor (static and postural), which makes a differential diagnosis more difficult. One characteristic that can be verified is that, in most cases, the Parkinson's tremor is asymmetrical, when affecting more than one side of the body, or it can be unilateral.[3] Another aspect commonly found is that the writing of Parkinson's disease patients is small and hardly readable, whereas it is wide and crooked in those with essential tremor.[14,16]

The essential tremor is the most common movement disturbance in clinical practice.[1,2] It is estimated that it affects up to one million people in the United States, without distinction of gender or ethnic group, in spite of having a strong familial component.[2] Up to 50% of patients have one or more cases among direct relatives.[3]

The appearance and progression of essential tremor do not follow a pre-established pattern and can arise in childhood as well as in adulthood, progressing slowly with age.[2,17,18]

The essential tremor is more visible with the hands in repose, decreasing the intensity during voluntary movements. In some patients, however, the tremor is more intense when they are in action. The most advanced stages include the static tremor, which hampers its differentiation in relation to Parkinson's disease.[2,19] Between 25–50% of the carriers of essential tremor are wrongly diagnosed with other diseases, particularly with Parkinson's disease.[3,20]

Patients with essential tremor are not predisposed to developing Parkinson's disease.[2] There are authors, however, who affirm that there is significant evidence that the essential tremor can precede the appearance of Parkinson's disease or even suggest that the

essential tremor is a risk factor for that disease.[21]

The body parts most commonly affected are the hands, but the essential tremor can also affect the head and the speech.[2] Usually the tremor is symmetrical, affecting both sides of the body equally.[3]

The etiology and the physiopathology of the essential tremor have not been completely elucidated yet. Autopsy of carriers of this disturbance does not demonstrate any signs of abnormality, and computed tomography (CT) and magnetic resonance imaging (MRI) scans also do not show signs.[3] Some studies point to an increase in the consumption of glucose and in the blood flow in the red nucleus, cerebellum, and thalamus, which is bilaterally seen on positron emission tomography (PET) scans.[3] The theoretical origin of the existence of a central oscillator is reinforced by the benefits that some patients obtain with the thalamotomy or with the implantation of electrodes in the thalamus (deep brain stimulation).[16]

The frequency of tremor is one of the aspects of these diseases that characterize each of them, yet there is currently no consensus in the literature on the frequency of tremor. There is a significant variation between the numerous published works (Table I).

IV. EPIDEMIOLOGY, PREVALENCE AND CONSEQUENCES

Most people consider tremor a characteristic of old age, preventing these symptoms from being related in the medical visits and, as a consequence, preventing elderly people from receiving adequate treatment.[3]

The prevalence of essential tremor varies substantially, between 0.008–22%, depending on the study. In the works dedicated to population studies, this interval reduces considerably, from 0.4–3.9%. The main limitation of these studies is that the study cases originate from questionnaires instead of neurological examinations, which results in a smaller prevalence index. In more specific studies conducted in Turkey, the prevalence of essential tremor was 4% among individuals over 40 years of age. A similar study in Finland reached prevalence between 5–6% in the same age group.[7,27] There are also works that cite an incidence of 4% among the population over 40 years of age, reaching 14% among those over 65 years of age.[21] It is estimated that about one million people in the United States are diagnosed with essential tremor every year.[2]

There is no evidence of difference in essential tremor prevalence by function of sex or ethnic group.[2]

In the United States, between 1.5–2.5% of people over 70 years of

TABLE I. Characteristic Frequencies of the Tremor Related in the Literature for the Physiologic Tremor, Essential Tremor, and Parkinson's Disease

Work	Physiological Tremor	Parkinson's Disease	Essential Tremor
Wyne[1]	7-12 Hz	4-6 Hz	4-12 Hz
Anouti and Koller[2]	8-12 Hz	4-8 Hz	4-8 Hz
Bhidayasiri[16]		3-6 Hz	5-12 Hz
Cichaczewski and Cunha[22]	8-12 Hz	3-6 Hz	4-10 Hz
Charles et al.[23]	8-12 Hz	4-6 Hz	4-11 Hz
Mattos[24]	8-13 Hz	3-6 Hz	5-7 Hz
Rao et al.[13]	8-12 Hz	4-6 Hz	
Bain[25]	7-12 Hz	3-10 Hz	4-12 Hz
Louis[7]			4-12 Hz
Habib-ur-Rehman[4]	8-12 Hz		4-8 Hz
Köster et al.[26]	8-12 Hz		
Gonçalves et al.[27]			4-8 Hz
Murray[28]			6-12 Hz
Benito-León and Louis[20]			4-12 Hz
Bhomrah et al.[29]			4-12 Hz (hands); 2-8 Hz (head)
Taylor and Counsell[30]		3-5 Hz	
Kraus et al.[15]		3-6 Hz	
Klockgether[31]		4-7 Hz	
Smaga[32]	8-12 Hz	4-6 Hz	4-10 Hz
Hern[33]	6-12 Hz	4-5 Hz	

Note: Blank cells indicate that the values were not reported.

age are carriers of Parkinson's disease. The estimated prevalence is 150 to 200 per 100,000 inhabitants.[13] In the United Kingdom, about 30 to 40 patients are diagnosed every day.[30] In 1999, the social cost of this disease in the United States was around US$20 billion.[32]

The essential tremor is usually called senile tremor. In elderly people, it usually affects the upper limbs (95% of cases), the head (34%), the lower limbs (20%), the voice (12%), the face (5%), and the trunk (5%).[3] Essential tremor usually affects adults between 60 and 70 years of age, but it is not surprising to also find younger patients affected by it.[16]

In the study by Tallon-Barranco et al.[34] of 357 patients with

essential tremor in Madrid, Spain, the average age of its appearance was 49.2 years, and there was a maximum prevalence between the sixth and the seventh life decades. Louis et al.[35] mention a median age of the essential tremor appearance of 43.3 years, with a peak between 60 and 70 years of age. The study also revealed, based on clinical examination, that the later in life the disease arises, the quicker it evolves.

Some works reveal that 1% of people over 65 years of age are carriers of Parkinson's disease, and this index doubles among the population over 85 years of age.[13]

V. CAUSES AND CONSEQUENCES

Although the characteristics of tremors have been studied and documented, we do not know their causes precisely yet, which leads to disagreements as to classification and treatment.[2,26] Another obstacle is the possibility of various kinds of tremors occurring in the same patient.[1] Some discoveries have been made about the physiopathological origins of Parkinson's disease and the essential tremor, but we still do not know for sure the cause that determines their appearance.[20]

Several factors generate oscillation in the central nervous system and can originate tremor. The most important ones are the ventromedial nucleus of the thalamus, the red cerebellar nucleus, and the bulbar olive, which constitute the thalamus-cerebellum-olive circuit. Basal ganglions, which are the parts of the brain most affected by Parkinson's disease, also produce oscillatory activity. Because all these structures are interconnected, it is not possible to accurately establish which of them is responsible for the tremor diagnosed in each patient.[36]

In Parkinson's disease, it has already been discovered that there is a deterioration of the black substance of the brain and the presence of Lewy bodies.[2] The black substance is the brain region responsible for the production of dopamine, a neurotransmitter that regulates movements. With the loss of neurons that produce that substance, there is a reduction. The Lewy bodies are abnormal protein aggregates that are formed within the neurons impairing their function and leading to their destruction. The presence of Lewy bodies is considered a pre-requirement for the diagnosis of the disease, although they have already also been found in dementia with Lewy bodies (DLB), which is neurodegenerative pathology.[31]

The histopathological results achieved in the autopsy of patients

with essential tremor are not conclusive because they demonstrate several kinds of different alterations, including neurodegenerative cerebellar alterations and the presence of Lewy bodies, which are traditionally associated with Parkinson's disease. In this latter case, the authors point out that because it is also possible for patients with essential tremor to develop Parkinson's disease, the presence of Lewy bodies cannot be definitively associated with essential tremor.[20]

Some studies suggest that up to 50% of the patients with essential tremor have a positive family history.[3,16,37] The opposite, on the other hand, has been proven as well. That is to say, more than 50% of the patients declare a negative family history.[20] Apparently, the frequency of a positive family history is inversely proportional to the age when the pathology starts. Three loci possibly related to the disease have already been found in chromosomes 3q13, 2p24.1, and 6p23; however, the family studies have not been conclusive.[37]

The study by Tanner et al[38] of 193 pairs of twins did not find significant results that indicated a genetic cause of Parkinson's disease, although there was a greater incidence in both siblings when the disease started before 50 years of age.

Tremor can lead to a physical and social deterioration and it can be a symptom of other more complex syndromes.[2] Because the static tremor does not affect voluntary activity, it usually does not cause limitation in daily actions, but it may cause embarrassment in activities that include a pause such as manipulating utensils and writing.[1]

The essential tremor does not affect longevity; however, it significantly affects the patient's quality of life.[2] In spite of research demonstrating that essential tremor does not augment the risk of death for patients, there are little data to support this affirmation.[7]

In addition to the physical deterioration caused by several disturbances associated with Parkinson's disease, dementia is one of the main problems in patients in an advanced stage of the disease. There are reports indicating that dementia affects around 12.4% of the patients aged between 50 and 59 years and reaches 68.7% of the patients over 80 years of age.[31]

VI. METHODS FOR DETECTION

VI.A. Conventional Clinical Methods

The clinical evaluation of patients with tremor is based mainly on patterns developed through the observation of study groups dedicated to the survey of the characteristics and evolution of the diseases.

The most used pattern for Parkinson's disease is the Unified Parkinson's Disease Rating Scale (UPDRS). The UPDRS was created in 1987 by an international committee of experts with the objective that it be used as a clinical tool for the quantitative and therapeutic evaluation of patients with this disorder. In 2001, the Movement Disorder Society (MDS), an international entity of specialists in movement disorders, published some criticism about the original scale and recommended the development of a new version. The result, named MDS-sponsored UPDRS Revision (MDS-UPDRS), was published in 2007.[39,40]

The MDS-UPDRS scale consists of a list of issues divided into four parts, to which values from 0 to 4 should be attributed, depending on the seriousness: 0 - normal or without problems; 1- minimal problems; 2 - mild problems; 3 - moderate problems; and 4 - severe problems. Some issues should be evaluated according to the response from the patients themselves.[14,39,40]

Another scale used to evaluate Parkinson's patients is the Hoehn and Yahr scale. It was created in 1967 and classifies patients into six stages of evolution of the disease (index from 0 to 5). Later, in 2001, Shenkman suggested the inclusion of two intermediate stages, creating the Hoehn and Yahr modified scale, which is less used by the medical community.[41]

The clinical scale most used in the literature for evaluation of essential tremor is the scale from the Washington Heights-Inwood Genetic Study of Essential Tremor (WHIGET). This group of WHIGET studies started in 1955 with the aim to investigate the genetic aspects of essential tremor using methodologies that had not yet been applied. As part of this program, a new ensemble of clinical criteria was developed for diagnosis of the disease.[42]

Research in the literature includes studies that use the Webster scale (for Parkinson's disease)[43,44] and the Tremor Rating Scale (TRS), which is used for Parkinson's disease as well as for the essential tremor. [44,45]

VI.B. Methods of Measurement in the Laboratory

The main methods used for the measurement of the tremors in the laboratory are accelerometry, electromyography (EMG), and the spirogram, with the latter used in smaller proportion.

Accelerometry is achieved by means of accelerometers, which measure static or dynamic acceleration forces such as the force of gravity that actuates on a body part or the movement caused by

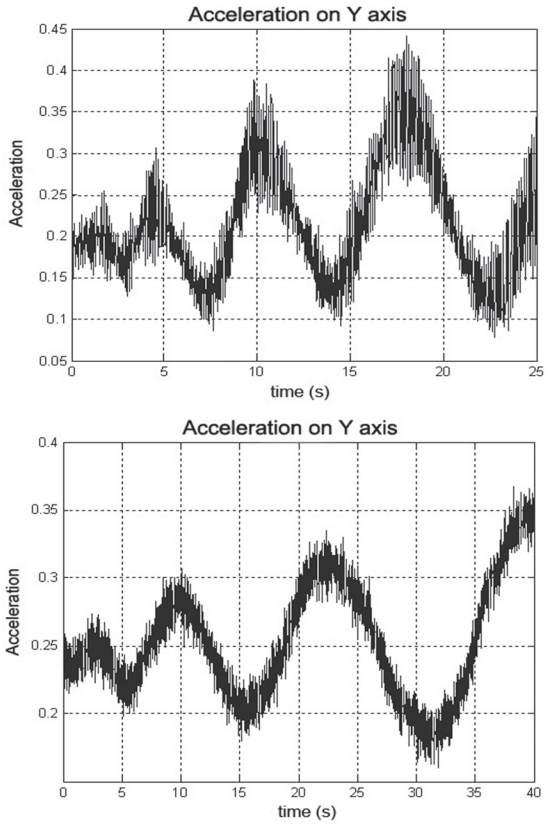

FIGURE 1. Examples of tremor measurement for accelerometry. (Top) Patient with tremor; (Bottom) Normal patient.

the tremor. There are several kinds of accelerometers. The two most common are based on the piezoelectric effect or on the capacitance variation. In the first type, a microscopic crystal, sensitive to the acceleration forces, generates a voltage that can be measured. In comparison, accelerometers by difference of capacitance have two microstructures positioned in such a way that there is a certain capacitance between them. The acceleration forces move these structures, modifying the capacitance and permitting that this variation be transformed into a measurable voltage.

In the studies of tremor measurement that use accelerometers, one or more units is fixed on the affected part, for example, on the fingers or on the dorsal region of the hands to measure the movements caused by the tremor (Figure 1).

Another tool for the detection of tremor is the electromyogram.

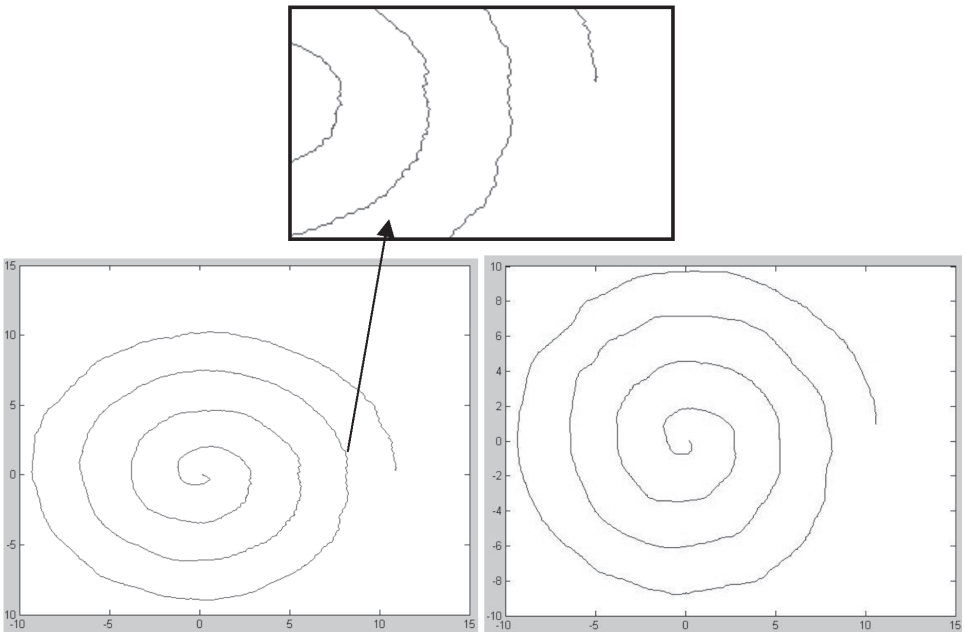

FIGURE 2. Examples of spirogram. (Left) Patient with accentuated physiologic tremor; (Right) Normal patient. The circle in the illustration of the left defines the area where the presence of the tremor is more evident.

In this case, surface electrodes are fixed usually on the flexor and extensor muscles of the forearm, stuck with elastic or adhesive tapes, and the electromyographic activity is detected.

The digital spirogram is performed by analyzing the drawing made by the patient on a spiral model positioned on a digitizer table. The digitizer table is a surface sensitive to the touch of a special pen.

The tremor test uses models of Archimedes' spirals that are characterized by the uniform distance between the spirals. The patient should accompany the model of the spiral using the pen, which allows the registration of the variations that occurred in the drawing in function of the tremor.[46]

By analyzing the variations in the attendance of the lines of the spiral, it is possible to detect the intensity of the tremor (Figure 2).

VII. METHODS FOR ANALYSIS

For all of the exams, the registered signals are, usually, transformed in digital sequences and stored in a computer for subsequent analysis.

That analysis uses traditional techniques and modern statistical and mathematical algorithms for the evaluation of the data.

The methods used more often, as indicated in the published literature, are the spectral analyses, which are mainly based on the Fourier transform. The current state of the art does not allow for identification of which strategy of tremor measurement is more efficient or more suitable, or which of the analysis methods is more necessary or effective.

We should consider that two situations do not exist with enough similarities to be compared. In other words, the published works possess different samples (geographical area, age group, aggravation of the pathology, etc) and they use different methodologies for the measurement of the tremor (protocol). Therefore, it is practically impossible to evaluate which of the methods is more necessary or which is more appropriate for each situation (Table II). A review of the literature indicates that researchers use the fast Fourier transformed (FFT) technique more, regardless of the signal type, the pathology, and the used samples. Some works associate the FFT with other methods for obtaining specific results.

Some authors tried to compare some techniques for analysis of physiologic signals, even if they are not directly associated with the tremor study (Table III).

As can be observed, an ideal method does not exist for the study of the tremors. If it were possible to access the data used in some of those studies so that different techniques could be applied, perhaps new comparative research could identify, for a similar sample and protocol, which of the methods of spectral estimation is more appropriate for pathological tremors.

VIII. DISCUSSION AND CONCLUSION

Considering that there is vast literature published regarding the main movement disturbances that cause tremors and that, even so, there are still controversies on several aspects involved in those diseases, the tremor is still a field of study that needs to be better explored. That is particularly true considering the evidence that the population more prone to having those pathologies is comprised of elderly people, who are already particularly sensitive to other problems resulting from age and the reduction in body function.

The study of tremors in senior people becomes important considering the proportional increase in the population of that age group in the last decades. A report published by the Statistical Office

TABLE II. Studies on Detection and Analysis of Tremor: Protocols and Analysis Techniques

Authors	Pathology	Examinations	Sample	Algorithm
Caviness et al.[47]	MP	EEG and EMG	20 MP, 20 control	FFT, analysis of coherence
Cichaczewski and Cunha[22]	MP, TE, Tremor de Holmes	Accelerometer	11 MP, 1 TE, 1 Holmes (43-80 years)	FFT
Elble et al.[48]	Various pathologies	Accelerometer Spirogram	959 patients (4 clinics) (18-102 years)	FFT, coherence between amplitude and TRS scale
Farkas et al.[9]	MP, TE	Accelerometer	95 patients 37 controls	FFT
Piboolnurak et al.[49]	Psychogenic Tremor	Accelerometer EMG	92 patients	FFT
Sowman and Türker[50]	Physiological Psychogenic Tremor (jaw)	EMG	(ni)	FFT
O'Suilleabhain and Matsumoto[10]	MP, TE, Psychogenic Tremor	EMG	35 patients	FFT, Wigner Distribution
Wang et al.[51]	MP	EMG and local field potential of the subthalamic nucleus	6 patients	FFT
Ben-Paz et al.[52]	MP	Accelerometer	22 patients	Welch FT
Lauk et al.[53]	Various	EMG, Accelerometer	(ni)	FT, direct spectral estimate
Machowska-Majchrzak et al.[11]	MP, TE, cerebellar Tremor	Accelerometer	96 patients	FFT, Hanning window

TABLE II. Studies on Detection and Analysis of Tremor: Protocols and Analysis Techniques (continued)

Authors	Pathology	Examinations	Sample	Algorithm
Moore et al.[54]	MP	Gyroscopes	(ni)	FFT, Hanning window
Keogh[55]	Physiological Tremor	Own equipment (EMG + Laser)	8 patients	Coherence analysis, Hanning window
Lima et al.[56]	(ni)	(ni)	(ni)	Empirical Mode Decomposition (EMD), Hilbert spectrum
Gao and Tung[57]	Various	Accelerometer	(ni)	Time-dependent exponent, curves of logarithmic displacement
Hellwig et al.[58]	TE	EEG, EMG, Magneto-encephalogram	10 patients	Direct spectral estimate, Bartlett window
Jakubowski et al.[59]	MP, TE, Physiological Tremor	Accelerometer	(ni)	Polyspectrum of high order, neural network
Journée et al.[60]	MP	EMG	2 patients	Second Order Movement Function (SOMF)
Lauk et al.[12]	MP, TE	EMG	10 TE, 6 MP	Direct spectral estimate
Riviere et al.[61]	(ni)	Spirogram	(ni)	Weighted frequency Fourier linear combiner (WFLC)
Rocon et al.[62]	Various	Gyroscopes	31 patients	EMD, Hilbert spectrum

(ni)—not informed; MP—Parkinson's disease; TE—essential tremor; EMG—electromyography; EEG—electroencephalography; FT—Fourier transformed; FFT—quick Fourier transformed; TRS—Tremor Rating Scale; EMD—empirical mode decomposition

TABLE III. Comparative Studies of Algorithms for Physiological Signals Analysis

Authors	Techniques	Signals	Conclusion
Akin[63]	FFT and wavelet	EEG	Wavelet method is the best for the detection of cerebral dysfunctions.
Bruns[64]	FFT, Hilbert and wavelet spectrum	Neuronal signals	The three methods are mathematically equivalent and they produce similar results, without significant differences, when they are used in the spectral analysis.
Issartel et al.[65]	FFT, wavelet	EMG	The wavelet method is better because it permits access to the whole complexity of a signal in terms of frequency, time, and phase.
Spyers-Ashby et al.[66]	FFT, auto-regression	(ni)	The auto-regressive method produces a spectrum of superior quality for short data sequences.
Wang et al.[51]	SFT and continuous wavelet	Subthalamic neuronal signals	Both methods produce similar results, although the wavelet presents a better temporal resolution, even though with a greater distortion in higher frequencies.

(ni)—not informed; EMG—electromyography; EEG—electroencephalography; FFT—quick Fourier transformed; SFT—short Fourier transformed

of European Communities affirms that about 17% of the European Union population in 2005 was more than 65 years of age, and that percentage will be 30% in 2050.[67] In Brazil, according to the Brazilian Institute of Geography and Statistics (IBGE), the median life expectancy was 66.93 years in 1991 and will be 78.33 years in 2030. In addition, the life expectancy of 60-year-olds will increase from 18.69% to 23.47% in the same period.[68] These data demonstrate the importance of understanding the diseases that affect the senior age group specifically, to improve the quality of life of that population and to reduce the economic and social costs that those diseases provoke all over the world.

Although there have been reported cases of ET and MP in younger patients, the consensus in the literature is that the larger incidence happens in the older age groups, including registry of alterations in the characteristics of tremor with the progression of age.[1] The largest challenge, however, is that we have not yet discovered the exact cause of the appearance of these diseases.

As shown in Tables II and III, it is not possible to reach any conclusions on the most appropriate methodologies for the detection and diagnosis of tremor. Because the presented works are based on different factors — such as frequency of the tremor, evolution of the pathologies, different age groups, and different pathologies — comparison between the multiple studies is limited. To obtain a satisfactory conclusion, it would be necessary to use the multiple detection and analysis methods on a similar sample of records, working with homogeneous parameters and unique protocols. Unfortunately, that is not possible with the studies already published in the literature.

Because the global population is getting older and tremor is an important feature that prejudices their quality of life, works about pathologies that provoke tremors must be more specific to help bridge gaps in the current research. It is also necessary to enlarge samples to include people from all over the world, and to establish some standards that allow studies to be compared and analyzed under the same patterns.

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