Grand Rounds

Tremor

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Tremor, defined as a rhythmic and involuntary movement of any body part, is the most prevalent movement disorder, affecting millions of people in the United States. All adults have varying degrees of physiological tremor so it is imperative to distinguish physiological tremor from pathological tremor types. Tremor is not inherently dangerous, but it can cause significant disability at home and in the workplace. Common tremors like essential tremor and Parkinson disease tremor can be recognized by most clinicians at the early stages for the initiation of disease-specific medical therapies. Less common tremors, such as those induced by drugs or brain lesions, are also important to recognize because they may be more refractory to medical therapies and may require earlier referral to a neurological specialist. In patients with the most progressive and severe tremors that are resistant to medical therapies, surgical interventions are available and typically target deep brain regions with stimulation or lesioning. This Grand Rounds review describes the evaluation and evidence-based management of the most common tremors, essential tremor and Parkinson disease tremor.

JAMA. 2014;311(9):948-954. doi:10.1001/jama.2014.1397

Video at jama.com

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Section Editor: Mary McGrae McDermott, MD, Senior Editor, *JAMA*.

This article is based on a Grand Rounds presented at the National Institutes of Health Clinical Center on January 9, 2013.

Patient Presentations

Case 1

An 85-year-old right-handed woman developed tremor of the head 20 years prior to presentation. Her tremor evolved to affect her dominant right hand and eventually her left hand and voice. Tremor now interferes with tasks at home, including writing and eating, and also professionally as a painter. Larger amplitude movements such as dressing and bathing are accomplished without difficulty. She has marked reduction in tremor with alcohol intake and often finds that a glass of wine prior to meals enables her to eat more easily (**Figure**, panel A). Her mother and maternal grandmother also had tremor.

On examination, there is pronounced tremor of the head without abnormal head posturing. Her voice is tremulous. Tremor is absent at rest but becomes evident when holding her hands outstretched and especially when holding her hands under her nose. The tremor interferes with smooth execution of tasks like writing (Figure, panel B) and pouring. Her gait is normal with regard to balance, arm swing, and stride length. Hand tremor is not apparent during ambulation (see **Video** at jama.com).

Case 2

A 50-year-old right-handed security officer developed dominant hand tremor 5 years ago. Within about 2 years, he lost his ability to qualify for firearms accuracy. His mother had a questionable diagnosis of Parkinson disease. Neither alcohol nor propranolol affects his tremor. The tremor was controlled for about 2 years with 25 mg of carbidopa and 250 mg of levodopa (both taken orally 4 times per day).

The examination is notable for severe resting tremor of the right hand and leg. Slight bradykinesia and micrographia are evident compared with the contralateral, left side (Figure, panel B). Muscle tone is increased on the right. The gait is slightly slow; however, step height, stride length, and tandem walking are normal. Postural reflexes and balance are preserved (see Video at jama.com).

Methods

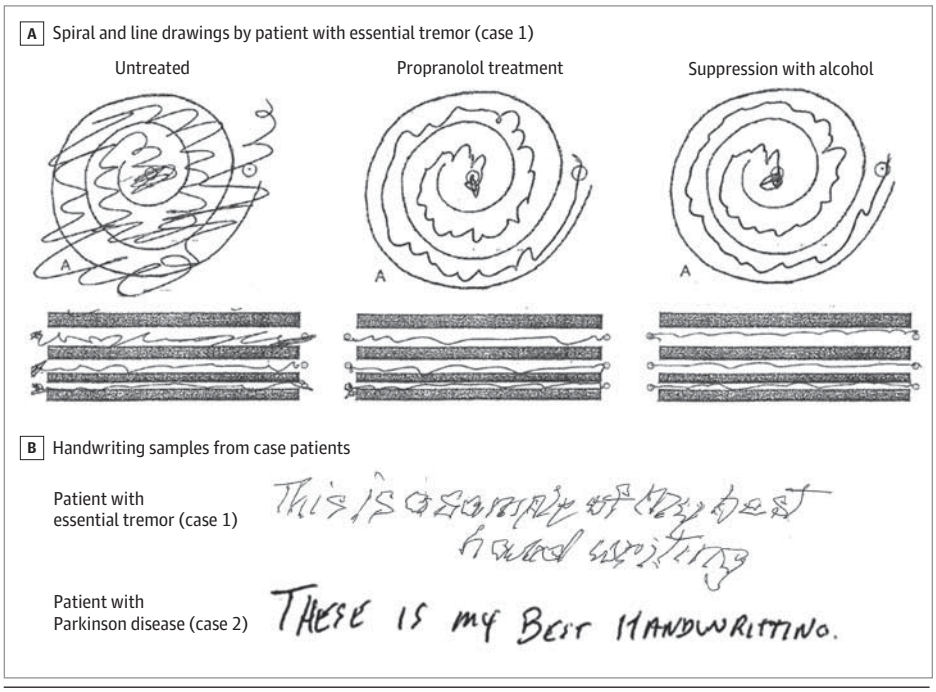
A PubMed search was conducted for pharmacological treatment of essential tremor and Parkinson disease tremor. Using the search terms *essential tremor* and *treatment* and limiting the results to clinical trials published in English, 226 results were returned. Of these 226, 131 were unique reports of clinical trials with pharmacotherapy. Using the search terms *Parkinson's disease* and *tremor* and limiting results to clinical trials published in English, 443 results were returned. Of these 443, 27 were unique reports of clinical trials with medical treatment for Parkinson disease tremor. Because Parkinson disease is a diffuse neurodegenerative disorder characterized by multiple motor features, most Parkinson disease clinical trials assess overall motor status rather than focusing on tremor alone. Therefore, we also included in our analysis the results from 3 large multicenter trials studying levodopa (ELLDOPA study[1]), levodopa vs pramipexole (CALM-PD study[2]), and selegiline (DATATOP[3]) in Parkinson disease.

Discussion

Prevalence and Clinical Significance of Tremor

Tremor is extremely common. Once considered a benign component of aging, essential tremor is now recognized as the most common pathological tremor.[4] An estimated 10 million to 20 million in-

Figure. Spiral and Line Drawings and Handwriting Samples



A, Case 1, a patient with essential tremor at different time intervals. Her tremor responds to propranolol, a first-line medication used for essential tremor (middle). Additionally, her tremor suppresses with alcohol intake (right). B, In a patient with essential tremor, writing may be sloppy and messy but of normal size. In a patient with Parkinson disease tremor, bradykinesia with writing manifests as micrographia characterized by decremental letter size.

dividuals living in the United States have essential tremor and estimates from population studies worldwide range from 0.4% to 6.3%[4]; however, the true prevalence is difficult to determine because patients often endure tremor without seeking medical attention.[5] Parkinson disease affects more than 1 million individuals living in the United States with an estimated incidence of 1% for those with age older than 60 years.[6] Adults of all races can be affected with Parkinson disease, with a consistent tendency worldwide to occur in those with age older than 60 years, in men, and in nonsmokers.[7]

Tremor can be disabling at home and in the workplace. Tremor-related disabilities often begin as early as the second decade and can progress to affect employment.[8-12] The psychological toll of tremor has been shown with general health assessments in which emotional effects may be more significant than physical disabilities.[11,13,14] Patients may develop social embarrassment[15] and even depression.[11]

Because of its high prevalence, clinicians of all specialties will encounter tremor in routine practice. It is important to distinguish pathological tremor from common physiological tremor. Early identification and proper treatment of pathological tremors, even though not disease modifying, can provide patients with improved quality of life sooner. Patients with unusual tremors should be referred to a neurology subspecialist.

Tremor Evaluation

History Taking

The most common tremulous diseases encountered in general or neurological practice are essential tremor and Parkinson disease. Tremor is a clinical diagnosis based entirely on the patient's history and neurological examination. The history often elucidates the origin when tremor is due to a specific event (eg, stroke or head injury) or disease (eg, multiple sclerosis). The initial manifestation varies. Tremor presenting asymmetrically in the thumb or a finger often suggests Parkinson disease, whereas bilateral and symmetrical tremor with action may suggest a systemic cause, metabolic derangement, or medication effect.

Tremor presenting at a young age in an otherwise healthy person may represent essential tremor, particularly when there is a positive family history. A detailed review of medications, especially for lithium or valproate, is imperative to identify drug-induced tremors, which can manifest with stable doses and typically reverse with medication cessation. Atypical and typical neuroleptic medications that block dopamine can induce parkinsonism with resting tremor that is almost indistinguishable from idiopathic Parkinson disease.

Physical Examination

A typical approach is to distinguish tremor by phase of movement, distribution, and frequency.[16] Resting tremor is best assessed with the patient in a quiet, supine position with the mouth slightly opened. Asking the patient to perform a mental task, such as counting backward, accentuates the resting tremor of Parkinson disease and suppresses any resting component of essential tremor.

Action tremor occurs with volitional movement and includes postural, kinetic, intention, isometric, and task-specific tremors (**Box 1**). Postural tremor can be observed by asking the patient to hold their hands either outstretched or just below the chin for 20 to 30 seconds. Patients may report greater postural tremor when holding a weighted object, such as a book or glass. Postural tremor of essential tremor begins during the act of assuming a position or stance (eg, hands outstretched).[17] Postural tremor of Parkinson disease typically reemerges in a latent fashion after a body position is assumed (eg, arms outstretched). Kinetic tremors are easily assessed at the bedside with finger-nose testing, but the true severity is more accurately elicited during coordinated activities like writing, feeding, or drinking. Task-specific tremors are often unrec-

Box 1. Tremor Definitions

Types of Involuntary Movements

Tremor: rhythmic and involuntary movement of any body part.

Dystonia: abnormal posturing or twisting movements from inappropriate muscle contraction or muscle group co-contractions. Arises from aberrant impulses sent from the brain.

Chorea: increased involuntary movements of a writhing, random pattern.

Dyskinesia: excessive involuntary movements often with chorea as the major component (eg, tardive dyskinesia or levodopa-induced dyskinesia).

Myoclonus: brief muscle jerks that can originate from the brain, spinal cord, or peripheral nerves.

Asterixis: brief movements from loss of muscle tone (negative myoclonus).

Clonus: rhythmic movement from hyperactive stretch reflex.

Types of Tremor

Resting: tremor present in a body part that is fully supported against gravity and that is not associated with any voluntary activity.

Action: tremor present with any voluntary movement of a body part.

Types of Action Tremors

Postural: tremor present while holding a position against gravity.

Kinetic: tremor with volitional movement that is unchanged throughout all phases of the movement.

Intention: tremor that increases in amplitude at target.

Task-specific: tremor that appears or is exacerbated by a specific movement.

Isometric (includes orthostatic): present with contraction of muscle against resistance without movement of the affected body part.

Box 2. Types of Tremor

Physiological tremor: kinetic and postural tremor of low amplitude and high frequency

Essential tremor: kinetic and postural tremor of moderate frequency

Parkinson disease tremor: rest tremor; may have a postural component that resets or reappears after a movement occurs; accompanying features may include bradykinesia, rigidity, masked face

Medication-induced tremor: variable clinical characteristics, mostly action or postural via enhancing physiological tremor; medications include valproic acid, neuroleptics, lithium, selective serotonin reuptake inhibitors, β-agonist (albuterol), central nervous system stimulants (methylphenidate), central nervous system depressants, rebound phenomena (ethanol, benzodiazepines)

Lesional tremor: multiple sclerosis, stroke, posttraumatic, cerebellar

Dystonic tremor: coarse, irregular tremor due to inappropriate, centrally mediated muscle contractions; may be task-specific, postural, kinetic, and of variable frequency; abnormal posturing or torsion may be evidenced in the same distribution as the tremor

Other neurodegenerative tremor: fragile X tremor ataxia syndrome, myoclonus-dystonia

Psychogenic: tremor due to psychosomatic factors

ognized and become evident during refined activities like writing, music playing, or occupational activities. Orthostatic tremor develops during isometric contraction of limbs while holding a position such as holding hands outstretched, and is more prominent when the patient is standing than when the patient is walking.

The distribution of tremor is also helpful for diagnosing tremor origin. Tremor in the face (eg, lips or chin) or a single finger may be more indicative of Parkinson disease. Isolated head tremor may be caused by essential tremor or cervical dystonia. Jaw tremor can be seen in both essential tremor and Parkinson disease. Tremor frequency may be classified as low (<4 Hz), medium (4-7 Hz), or high (>7 Hz), and the amplitude of a tremor is considered severe when it approaches or exceeds 4 cm.[18]

The neurological examination is intended to identify physical signs for an accurate diagnosis of a tremor syndrome. Bradykinesia, rigidity, masked face, hypophonic speech, or asymmetrical arm-swing or stride length when walking all suggest Parkinson disease tremor. Tremors caused by structural lesions like stroke or multiple sclerosis demyelinating plaques may be associated with focal neurological signs of weakness, reflex asymmetry, hemiataxia, or spasticity.

Because tremor is defined as an involuntary and rhythmic movement of any body part, tremor can appear similar to other involuntary movements like myoclonus, asterixis, and epilepsia partialis continua[16] (Box 1). Patients with Parkinson disease may confuse tremor with dyskinesia. This distinction can be made by the clinician because resting tremor is rhythmic and accentuated in the unmedicated state, whereas dyskinesia is usually prominent in the medicated state.

Imaging

Imaging and other diagnostic testing are not typically required to diagnose the origin of tremor. Magnetic resonance imaging can be used to rule out rare, structural causes of parkinsonism, and tremors related to multiple sclerosis, cerebellar disease, or posttraumatic events. Nuclear imaging of dopamine transporters, such as ioflupane single-photon emission computed tomography, which has been approved by the US Food and Drug Administration, can help distinguish Parkinson disease from conditions in which dopaminergic tone is normal, namely essential tremor or psychogenic tremor. However, there has not been widespread adoption of this technique because most tremors can be accurately diagnosed using clinical examination alone.

Differential Diagnosis of Tremor

There are many other types of tremor relating to neurological diseases, neurodegenerative conditions, medications, brain lesions, and hereditary or genetic factors. However, these tremors are much less common. A simple classification scheme may be useful for most clinicians (**Box 2**).

Physiological Tremor

All humans have tremor that is physiological and may not be readily apparent without magnification. This fine amplitude, higher frequency tremor is not disabling like a pathological tremor, but it can be embarrassing for patients. Physiological tremor results predominantly from homeostatic, peripheral movements of muscles and

joints to maintain posture or move limbs.[19] Physiological tremor becomes more pronounced with central stimulant medications (eg, methylphenidate, dextroamphetamine), sleep deprivation, and stress. Ethanol, a central nervous system depressant, can cause tremor in a rebound phenomena following overuse or withdrawal when dependent. Caffeine, nicotine, and β-agonist inhalers worsen physiological tremor and typically reverse with their cessation. Enhanced physiological tremor is visible in the absence of magnifying factors or develops with a lower threshold than would be expected typically.

Essential Tremor

Essential tremor is primarily a monosymptomatic condition affecting the hands; however, some associations have been made with cognitive impairment,[20] neuropathy, and gait disorders.[21-23] The incidence of essential tremor peaks in a bimodal fashion with age of onset common during adolescence or early adulthood or when older than 60 years.[10,12] More than half of patients with essential tremor have affected family members. Studies of twins report higher, but not absolute, concordance rates in monozygotic twins. Therefore, factors other than genetics are likely involved.[24]

Even at the early stages, essential tremor can be distinguished from the tremor associated with Parkinson disease (**Table 1**). The clinical diagnosis of essential tremor is often made by general practitioners, although neurological specialists may become involved in cases of uncertain diagnosis or difficult treatment. Essential tremor usually presents with postural and kinetic tremor of the hands, although axial tremor of the head, neck, or voice may precede or be associated with appendicular tremor. Handwriting with essential tremor is typically large and messy.

The pathophysiological basis of essential tremor remains unknown. Improvement with ethanol and primidone (of which phenobarbital is a metabolite) implicate a possible role of GABAergic transmission (ie, activation of γ-aminobutyric acid [GABA] receptors and release of GABA by endogenous or pharmacological modulators); although some non-GABAergic compounds (eg, β-blockers and anticonvulsants) are effective for essential tremor, whereas other GABAergic compounds (ie, benzodiazepines and phenobarbital) are not. Electrophysiological recordings from stereotactic tremor surgery has identified "tremor cells" that synchronously discharge with muscle activity, but it remains unknown whether this is a cause or result of the disease.[25]

Various imaging modalities have also implicated cerebellar dysfunction as a potential cause in essential tremor including hypermetabolic activity identified by positron emission tomography,[26] activation of the ipsilateral cerebellum during writing tasks identified by functional magnetic resonance imaging,[27] altered cerebellar connections identified by diffusion tensor imaging,[28] and magnetic resonance spectroscopy comparison studies.[29] Postmortem examinations have been limited, but reports have shown Purkinje cell loss in the cerebellum with axonal swelling (termed *torpedoes*) compared with controls.[30-32]

Tremor of Parkinson Disease

Idiopathic Parkinson disease is a progressive neurodegenerative disorder that affects multiple regions of the central nervous system. The cardinal motor features of resting tremor, bradykinesia, and rigidity develop after dopaminergic cell loss of 50% to 70% in the substantia nigra.[33,34] The spectrum of motor symptoms in Parkinson disease can range from a purely akinetic-rigid subtype in which tremor is absent to a tremor-dominant subtype in which tremor is the earliest and most prominent feature.[35] Some patients with tremor-dominant disease may progress more slowly to postural instability or dementia.[36,37]

Striatal dopamine seems to correlate with akinesia, rigidity, and disease severity; however, it does not correlate with the presence or severity of tremor, suggesting perhaps a different pathophysiology for Parkinson disease tremor.[38,39] Both motor and nonmotor symptoms are associated with degeneration in the dopaminergic striatonigral system; however, Parkinson disease is a diffuse neurodegenerative condition affecting more than just the dopaminergic pathways.

The classic tremor of Parkinson disease is reported as a resting tremor of 4 Hz to 7 Hz that abolishes with volitional movement.[40] Based on the most commonly used diagnostic criteria for idiopathic Parkinson disease (the UK Brain Bank criteria[41]), tremor is not obligatory for the diagnosis like bradykinesia or the absence of early atypical features (eg, postural instability, dysautonomia). When tremor is present, it is important to note that rest tremor is of a greater degree than any kinetic component.[16]

As the disease progresses, tremor may change in terms of severity and distribution.[42] Parkinson disease tremor in the arms accentuates during gait when the hands are resting at the patient's sides. This contrasts with essential tremor in which tremor may diminish or completely subside during gait.[17] There can be cases of tremor that are difficult to distinguish between Parkinson disease and essential tremor (Table 1). Controversy exists as to whether an overlap syndrome between the 2 exists or whether some essential tremor cases progress to Parkinson disease.[43]

Table 1. Distinguishing Features Between Essential Tremor and Parkinson Disease Tremor

Clinical Evaluation	Essential Tremor	Parkinson Disease
History		
Age of onset	Bimodal (adolescence or early adulthood or age ≥65 y)	Incidence increases with age, particularly age ≥60 y
Family history	Common	Rare
Response to alcohol	Common	Never
Tremor assessment		
Phase of movement	Postural and kinetic plus resting if severe; quiesces when walking	Resting; reemerges after sustained posture, prominent when walking
Distribution	Head and voice	Mouth, tongue, and legs
Frequency, Hz	7-12	4-6
Neurological examination		
Handwriting	Sloppy with large, rhythmic strokes	Micrographic, decremental (decreasing size of movements)
Face	Normal expression	Reduced eye blink, masked facies, blunted emotional expression
Voice	Vocal tremor	Hypophonia
Gait	Normal	Stooped posture, shortened stride length and step height, reduced asymmetrical arm swing

Table 2. Summary of the Medical Management of Essential Tremor and Parkinson Disease Tremor

	Adverse Effects
Essential tremor	
First-line treatment	
Propranolol	Bradycardia, hypotension, erectile dysfunction
Primidone	Imbalance, sedation, vertigo
Second-line treatment	
Topiramate	Decreased appetite, sedation, cognitive slowing, risk of nephroliathesis
Gabapentin	Sedation
Atenolol	Same adverse effects as propranolol
Sotalol	Same adverse effects as propranolol
Alprazolam	Sedation, abuse potential
Parkinson disease tremor	
Dopaminergic agents for tremor, bradykinesia, and rigidity reduction	
Levodopa	Nausea, lightheadedness, sedation, dyskinesia
Dopamine agonists (eg, pramipexole, rotigotine, ropinirole)	Sedation, nausea, lightheadedness, impulse control disorder, dyskinesia
Monoamine oxidase B inhibitors (eg, selegiline, rasagiline)	Sedation, theoretical tyramine reaction with red wine or aged cheese
Catechol-O-methyltransferase inhibitors (eg, entacopone)	Sedation, orange urine
Nondopaminergic agents solely or primarily for tremor reduction	
Anticholinergic drugs (eg, trihexyphenidyl, benztropine)	Confusion, dry eyes, dry mouth, constipation
Amantadine	Hallucinations, confusion, lower extremity edema, livedo reticularis
Others with less evidence: zonisamide, primidone, budipine	Sedation

Other Tremors

There is a wide range of tremor conditions, and it is important to recognize infrequent, atypical tremors. Medication-induced tremor (Box 2) should be considered in anyone presenting with tremor because this can occur months after the initiation of a drug and often are easily treated.

Dystonia is the abnormal, inappropriate contraction of a muscle or group of muscles due to aberrant impulses sent from the brain. It can be idiopathic or secondary to structural lesions, typically involving the putamen of the basal ganglia. This abnormal contraction can lead to twisting, abnormal postures or tremor affecting the limbs, trunk, head, vocal cords, or face. Dystonic tremors are coarse, irregular, and may worsen with a particular posture or task. This contrasts with essential tremor in which the kinetic component is more or less constant throughout all positions. Dystonic tremor may occur with other involuntary movements including blepharospasm, torticollis, or spasmodic dysphonia. Isolated head tremor can be particularly challenging to distinguish between essential tremor and dystonic tremor (the latter of which can be exquisitely responsive to pharmacological treatment or botulinum toxin injections).[44]

When affecting the cerebellorubral and cerebellothalamic pathways, lesions of the brain due to the demyelinating plaques of multiple sclerosis can cause disabling proximal tremor and dyscoordination. Head trauma severe enough to injure brain stem regions, including the red nucleus (rubral), leads to both resting and action tremor of the proximal, axial muscles. Cerebellar tremors may be recognized with associated signs of dysmetria, ataxia, or both, as well as with cerebellar pathology identified by magnetic resonance imaging.

Psychogenic or functional tremor falls into the broader category termed *psychogenic neurological symptoms*. Commonly this can be seen as a conversion reaction to mood disorders or traumatic psychological or physical trauma, though underlying triggers can be varied and difficult to identify.[45] Psychogenic movement disorders as a whole (with tremor being the most common subtype) may account for 10% to 30% of new patient visits in a movement disorder neurology clinic.[45] Clinical features suggesting psychogenic tremor include sudden onset with severe presentations, inconsistent combinations of resting and postural or kinetic tremor, entrainment, and tremor that diminishes with distraction.[46] Entrainment is the change in frequency of tremor to that of a task performed in another body part. For example, a patient with left hand tremor who taps at various frequencies with the right hand will have a left hand that acquires those frequencies.

Management of Tremor

Compensatory Strategies for Tremor

Physical and occupational therapy are helpful in identifying adaptive strategies for tremor control regardless of whether medical or surgical intervention is being considered. Weighted utensils, button fasteners, adjustments during meals, and specialized computer keyboards can all be used to ease the disability of tremor.

Medical Therapies for Essential Tremor and Parkinson Disease Tremor

From our review of 131 studies, results from the 1970s through 1980s demonstrated consistent benefit with propranolol and primidone on tremor severity. More recent reports investigate use of β-blockers, antiepileptic drugs, alcohols, and GABA modulators, among others. Based on this evidence, the first-line therapy is propranolol or primidone. These therapies reduce hand tremor by 50% on validated clinical rating scales and with accelerometry.[47] Up to 30% of patients do not respond to first-line therapy or may experience intolerable adverse effects.[48] Longer-term survey data reveal that up to 56% of patients eventually discontinued their use.[49] Second-line medications demonstrating less consistent efficacy include topiramate, gabapentin, and atenolol, but not levetiracetam[47,50] (Table 2).

There is no consensus on the management of Parkinson disease tremor, primarily because of the variable nature of the disease and the need for individualized treatment. Additionally, unlike the other cardinal features of bradykinesia and rigidity, Parkinson disease tremor may be refractory to pharmacological treatment. The general consensus is that levodopa is the single most effective pharmacological agent in managing all Parkinson disease motor symptoms.

Larger clinical trials of Parkinson disease[1-3] have focused on reducing overall motor symptoms or burden of disease rather than on tremor alone. The studies we identified in our search that investigated only treatments for Parkinson disease tremor tended to corroborate the role of dopamine therapy as being an effective means of reducing tremor. Other agents shown to have benefit include anticholinergic drugs and clozapine. In general, pharmacological treat-

ment of Parkinson disease tremor is segregated into agents that act on the dopaminergic system and those that do not.

Levodopa is the most efficacious dopamine therapy and reduces motor signs; however, it can be associated with earlier development of motor fluctuations (ie, doses lasting for shorter intervals) and dyskinesia (ie, excessive, involuntary movement typically seen at the peak dose effect of levodopa).[51] Dopamine agonists stimulate postsynaptic receptors and can reduce symptoms with less risk for motor fluctuation development. However, they are not as effective in reducing motor symptoms during the later stages compared with levodopa and they have adverse effects including excessive daytime sleepiness, exacerbation of dysautonomia, and hallucinations. Monoamine oxidase B inhibitors reduce breakdown of dopamine in the synaptic junction but have not demonstrated compelling benefit for tremor.

Nondopaminergic agents used for tremor in Parkinson disease include the anticholinergic trihexyphenidyl, which is effective in tremor reduction, though its use can be limited by adverse effects such as cognitive slowing.[52] Amantadine has been used for decades for Parkinson disease motor symptoms, including tremor, though response can be variable in early disease and it is used for reducing levodopa-induced dyskinesia (Table 2).

Surgical Treatment for Tremor

The earliest surgery for tremor involved resection of the precentral motor cortex that harbored the "nervous impulses."[53] Now precise stereotactic surgeries are occasionally performed for severe, disabling tremors that are resistant to medical therapies. Prospective and retrospective comparisons of thalamic lesioning and deep brain stimulation report similar (69%-90%) control rates of appendicular tremor in essential tremor and Parkinson disease.[54-57] Deep brain stimulation, which is the primary procedure performed today, gained approval from the US Food and Drug Administration for essential tremor in 1997 and for Parkinson disease in 2002. The therapy can be implemented more safely for bilateral tremors, and electrical stimulation can be adjusted or reversed for stimulation-related adverse effects that are common (eg, paresthesia, dysarthria, or both).

Gamma knife thalamotomy or stereotactic radiation also has been associated with significantly improved tremor management.[58,59] More recently, a transcranial-focused ultrasound thalamotomy technique has been investigated in which acoustic energy is delivered through the intact cranium without surgery using real-time magnetic resonance monitoring of the treatment.[60]

Conclusions

Case 1

This is a classic case of familial essential tremor. The patient was started on propranolol, a first-line agent for essential tremor, with clear benefit. She has been stable for 10 years and is currently receiving a dose of 40 mg of propranolol (3 times per day). She has some residual tremor without limitations in her activities of daily living (Figure).

Case 2

Parkinson disease typically presents in a unilateral fashion and may affect the lower extremities. This patient has relatively greater tremor and less impairment from bradykinesia or rigidity. Gait dysfunction and postural instability, often considered nondopaminergic features, are absent in the early stages. Tremor-dominant subtypes can be similarly disabling as essential tremor and refractory to dopamine therapies.

After 5 years of disabling and medically refractory tremor, the patient underwent unilateral thalamic deep brain stimulation, which suppressed his tremor and allowed him to requalify for firearms accuracy as a security officer (see Video at jama.com). Tremor suppression persists at 2 years postoperatively, although he continues to take the same medication combination (25 mg of carbidopa and 250 mg of levodopa both taken orally 4 times per day) for his other parkinsonian features.

ARTICLE INFORMATION

Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Drs Elias and Shah received focused ultrasound research funding from Insightec Ltd and the Focused Ultrasound Foundation.

Additional Contributions: We thank Diane Huss, PT, DPT, NCS (University of Virginia), for obtaining the writing and video tremor assessments without financial compensation. We also thank the patients for providing permission to share their information.

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