

Clinical Note: How I Examine My Patient

The Clinical Evaluation of Parkinson's Tremor

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Abstract. Parkinson's disease harbours many different tremors that differ in distribution, frequency, and context in which they occur. A good clinical tremor assessment is important for weighing up possible differential diagnoses of Parkinson's disease, but also to measure the severity of the tremor as a basis for further tailored treatment. This can be challenging, because Parkinson's tremor amplitude is typically very variable and context-dependent. Here, we outline how we investigate Parkinson's tremor in the clinic. We describe a simple set of clinical tasks that can be used to constrain tremor variability (cognitive and motor co-activation, several specific limb postures). This may help to adequately characterize the tremor(s) occurring in a patient with Parkinson's disease.

Keywords: Parkinson's disease, clinical examination, tremor

INTRODUCTION

Resting tremor occurs in approximately 75% of patients with Parkinson's disease (PD), and is one of the most characteristic disease manifestations of PD. In fact, tremor was eponymous for the initial description of James Parkinson's famous "Essay about the shaking Palsy" that was published in 1817. Resting tremor is often the presenting sign of PD, and early-stage PD patients rank it as their second most troublesome symptom [1]. A diligent examination of a PD patient presenting with tremor is important – not only for weighing up possible differential diagnoses of PD, like essential tremor (ET), dystonic tremor or psychogenic tremor, but also to measure the severity of the tremor and to estimate how it affects the patient's daily life, as a basis for further tailored treatment. The clinical approach to tremor can be challenging because PD tremor is highly variable, even across the short time span of a neurological examination. Here, we will

outline how we investigate Parkinson's tremor in the clinic, and review the available clinical tests that can be used to constrain this variability (see Supplementary Table).

The different tremors of Parkinson's disease

PD harbors several different tremors that are variable in frequency, amplitude, distribution, constancy, context in which they occur, and provoking situations [2]. The classical Parkinson's tremor occurs at rest, is often asymmetric, has a distal maximum and a typical frequency of 4–6 Hz [3]. Many PD patients also have a postural tremor of the hands, which can have many different origins [4]. Most commonly (in 34–60% of the cases) this is the rest tremor returning when the hand has assumed a new stable position (this is called 're-emergent tremor'; see online video supplement). Therefore, the term "tremor of stability" may be more appropriate than "resting tremor" [2]. Although this has never been tested, re-emergent tremor probably has the same pathophysiology and response to treatment as resting tremor. Resting tremor does not necessarily disappear completely after a voluntary action, but

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it's amplitude is reduced in 90% of PD patients. In contrast, tremor is suppressed in only 6.5% of ET patients with resting tremor [5]. Other postural tremors often have a (slightly) higher frequency than resting tremor. They may have different etiologies, e.g. occurring in a dystonic limb, or resemble ET (although its pathophysiology is probably different from that of ET [6–8]). The frequencies of common tremor forms (such as dystonic tremor and ET) overlap with that of Parkinson's tremor. Therefore, electrophysiological frequency analysis cannot serve as diagnostic criterion but may be a supportive ancillary test in unclear cases. Note that clinical tremor assessments are as good as objective tremor measurements (e.g. accelerometry) in estimating tremor severity [9, 10]; therefore, an adequately trained clinical eye remains crucial.

HOW TO INVESTIGATE PARKINSON'S TREMOR

1. Tremor distribution. Parkinson's tremor can affect several parts of the body, typically involving the limbs, but sometimes also the lips and chin (in contrast to dystonic head tremor, where involvement of the lips and chin is rarely seen). Some patients have signature features such as a pill-rolling tremor, where there is a thumb flexion from neutral position. Such a pill-rolling tremor has important diagnostic value, as it is seen in only a limited number of conditions: apart from PD, it can also be seen in drug induced parkinsonism or in a limited number of atypical parkinsonism (MSA, PSP-P, and sporadically in Lewy body dementia). In contrast, however, patients with dystonic tremor often have a thumb extension tremor [11]. The form and distribution of tremor can vary within a single patient, depending on the limb position. Therefore, it is useful to look for resting tremor in different arm positions (e.g. during walking, sitting with hands in the lap, or hanging on the sides; see online video supplement). In many patients, the resting tremor amplitude reaches its maximum during walking, and sometimes the tremor is only visible during walking (when the arms are usually fully relaxed) [12]. Tremor assessment can therefore already start when walking with the patient to the examination room.

2. The context in which tremor occurs. Resting tremor occurs at rest, but it is not always easy to have a patient completely relaxed. When in doubt, we test for resting tremor when the patient is lying down on a bed, to rule out gravitational force and muscle co-contraction. When subjects are examined in a seated position, it may help to have the arms hanging

from the sides. In both cases, it is important to make sure that the full range of motion of the tremulous limb can be achieved (see online video supplement). When assessing resting tremor, two aspects are important: its maximum amplitude and the tremor constancy. Both items are now part of the MDS-UPDRS [13], and require the clinician's awareness during the whole examination.

To assess postural tremor, we use a few different postures: arms stretched out, the bat-winging position (which is more sensitive to proximal tremors, and to dystonic tremor), and wrist extension (this can also unveil negative myoclonus). It is useful to expose the patient's chest during these tasks, because the pectoral muscles may contract during dystonic posturing of the arm. Furthermore, asking the patient to slowly rotate the outstretched arms from pronation to supination may show a position-specific tremor – which is a sign of dystonic tremor.

When evaluating re-emergent tremor it is important to realize that small voluntary adaptation movements may prevent a re-emergent tremor to occur. Therefore, we usually ask patients to make a brief ballistic movement and then obtain a stable posture for up to 60 seconds. To assess resting tremor suppression by a voluntary movement (and to test for tremor re-emergence thereafter), wrist extension is often more suitable than the other postures, because this movement can be done rapidly (see online video supplement).

Kinetic tremor is typical for ET but also occurs in a significant portion of PD patients. To test for this, the finger-nose manoeuvre, the finger-chase or even more practical tests like drinking and pouring water from one cup into another are quick and sufficient tests to evaluate functional impairments in daily life (see online video supplement). Here clear instructions are essential to rule out possible compensation or suppression mechanisms. The patient should be told to perform the manoeuvre with a large range of motion by abducting the upper arms away from the chest wall. Otherwise the tremor could be suppressed by fixating the upper arm. Writing and drawing spirals or straight lines, as parts of the "Fahn-Tolosa-Marin Tremor rating scale" [14] can be used to easily monitor therapeutic effects in the clinic or at home over a longer period of time. If patients have an intention tremor, then this would signal the presence of cerebellar tremor.

3. Tasks that increase tremor amplitude. Many patients experience that their resting tremor markedly increases during situations that are stressful or require concentration. This in turn creates a feeling of embarrassment and stigmatisation, leading to a vicious circle.

The mechanism behind this modulation is unclear; both neuronal and hormonal (adrenalin) factors may play a role. It is unlikely that physiological tremor (which is increased during stress) aggravates PD resting tremor, since this tremor occurs at a different frequency and is usually of minor amplitude compared to the PD tremor. During physical examination, cognitive and motor tasks can be used to increase the tremor; this has been termed cognitive or motor co-activation. Often the conversation with the physician acts as a cognitive co-activation by inducing a higher stress level. To increase this effect, patients could be asked to perform cognitively challenging tasks under time pressure, such as counting backwards as fast as possible in steps of three or seven, or lexical fluency-testing (“name as many words starting with a particular letter”) [3, 15]. Raethjen et al. described the largest increase in amplitude to be after 2-3 minutes [16]. However, in our experience the duration of 1 minute (using several cognitive tasks in a row) is often already sufficient. Most patients are more sensitive to cognitive co-activation, but occasional patients show an amplitude increase (only) during motoric co-activation (e.g. when asked to open and close the contralateral hand toe tapping or walking (see online video supplement).

4. *Entrainment and pointing test.* These tests are important when the patient is suspected of having a psychogenic tremor. Some patients with genuine PD present with “elaboration”, i.e. a functional aggravation of their PD tremor [17]. When testing for entrainment, the patient is asked to perform a simple rhythmic movement (e.g. finger tapping or toe tapping) paced by the clinician or a metronome. This externally imposed rhythm must be lower than the tremor frequency (e.g. 1–3 Hz), and should not be in phase with the tremor [18]. A positive “entrainment” is present when the tremor frequency of the contralateral limb adapts to the externally imposed rhythm. However, mirror movements are frequent in PD (occurring in 30–90% of the cases) [19–21]. They may occur in the tremulous hand, influence the ongoing resting tremor, and can thus appear as “entrainment”. The “pointing test” involves asking the patient to make a rapid ballistic movement with the limb contralateral to the one where the tremor is examined. According to one report, the tremor stops invariably in patients with psychogenic tremor, but always continues in patients with PD (or other forms of organic tremor) [22]. However, in our experience, this test is not infallible: in some PD patients, the tremor may stop at the onset of a simple ballistic movement, while in some patients with psychogenic tremor, the tremor continues when

the contralateral ballistic movement is performed too slowly (Zach et al., unpublished).

CONCLUSION

Parkinson’s tremor is a highly variable symptom, but this variability can be constrained by using a simple set of clinical tasks (cognitive co-activation, motor co-activation, and a few specific postures). A correct classification of tremor may have consequences for treatment: although never formally tested, it is plausible to assume that re-emergent tremor has a similar response to dopaminergic drugs as resting tremor, while an ET-like postural tremor may respond better to beta blockers. Also, the correct estimation of tremor severity is important for assessing treatment effects, and for estimating the burden of the tremor.

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SUPPLEMENTARY MATERIAL

The supplementary video is available in the electronic version of this article: <http://dx.doi.org/10.3233/JPD-150650>.

Video: Tremor examination in a PD patient

The video shows the examination of rest-, postural and kinetic tremor, as well as entrainment and the pointing test in a PD patient (age:47, tremor-dominant PD since 8 years).

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Supplementary Table

Tremor Examination		
Rest Tremor	<i>During walking</i>	hands during walking pronated hands in the Lap
	<i>Sitting position</i>	forearms supported, hands hanging hanging on the sides
	<i>Supine position</i>	hands on the sides hands on the belly hands supported by pillows
Provocation	<i>cognitive co-activation</i>	counting backwards in steps of 3 or 7 lexical fluency
	<i>motoric co-activation</i>	finger tapping (contralateral hand) toe tapping
Postural Tremor		arms stretched out bat winging position wrist dorsiflexion*
Kinetic Tremor		finger-nose-(finger) manoeuvre finger-chase drinking from a cup pouring water from one cup into another
Entrainment	contralateral limb; frequency 1-3Hz	finger tapping hand gripping
Pointing test	contralateral hand; rapid movement	toe tapping hand lift grabbing a (static or moving) pen

*To search for negative myoclonus as well (flapping tremor).