Hands-on Course 8

MDS-ES/EAN: Neurophysiological study of tremor - Level 1

Neurophysiological study of tremor: How to do it in clinical practice

Rick Helmich
Nijmegen, The Netherlands

Email: Rick.Helmich@radboudumc.nl
Conflict of interest:
The author has no conflict of interest in relation to this manuscript

Key learning objectives

- The clinical questions. Participants will learn which clinical questions can be answered with a tremor assessment (and which questions cannot be answered).

- The basics. Participants will learn what the differences are between accelerometry and electromyography, and what are the standard measurements to collect during a tremor assessment.

- The interpretation. Participants will learn what the clinical relevance is of findings obtained during a tremor assessment, such as: tremor frequency, effect of limb loading, entrainment, effect of voluntary movements, coherence between two tremors.

Essential knowledge

The origin of tremor.

Tremor is defined as a rhythmic, oscillating movement of one or more body parts. Theoretically, tremor can be caused both by central and peripheral mechanisms. Central mechanisms may involve a single oscillator, an oscillating network, or both. Peripheral mechanisms may involve a mechanical oscillation (such as the force of blood ejection during cardiac systole, or irregularities in motor unit firing), a mechanical-reflex oscillation (such as entrainment of motor units, e.g. through muscle spindles responding to perturbations), or both.
Tremors that are considered to be largely of central origin are Parkinson’s tremor, essential tremor (ET), orthostatic tremor, and tremor in dystonia (dystonic tremor and tremor associated with dystonia)\(^3^,^4\). Tremor that are considered to be largely of peripheral origin are (enhanced) physiological tremor, drug-induced tremor, and neuropathic tremor. However, there is no clear distinction here: in many tremors, both peripheral and central factors contribute. For example, it has been shown that 7-8% of subjects with enhanced physiological tremor have a central origin\(^5\). This means that, like any ancillary investigation, neurophysiology cannot provide definite answers.

**What does neurophysiology add?**

A neurophysiological tremor assessment can quantify certain tremor features that are not visible to the clinical eye. Examples are tremor frequency (as well as the stability of tremor frequency over time) and coherence (which is the phase coupling between two separate tremors, indicative of a common generator). A neurophysiological tremor assessment can also serve to capture, or make record of, certain tremor features that can also be seen with the naked eye during (thorough) clinical examination. Examples are tremor entrainment (which is the modulation of tremor frequency by a concurrent voluntary movement of another limb in a different frequency), a slight pause of the tremor during a voluntary, ballistic movement with another limb, or the effect of a mental task on tremor amplitude (distraction). Finally, it should be borne in mind that a neurophysiological tremor assessment cannot capture clinical symptoms that are crucial for reaching a correct diagnosis, such as the presence of bradykinesia, subtle dystonic posturing, or ataxia during physical examination.
Clinical questions where a neurophysiological tremor assessment can provide meaningful answers are:

- Is the tremor of peripheral origin, central origin, or both?
- Are there objective signs of psychogenic tremor?
- What is the tremor frequency and what is the pattern of EMG activity associated with the tremor?

The basics.
Routine tremor assessment involves accelerometry of the tremulous limb (often the arms) and electromyography (EMG) measurements of the involved muscles (often wrist extensor and flexor muscles). Accelerometry measures the movement of the limb, while EMG measures the pattern of muscle activity that may (or may not) underlie these movements. Both measurements do not always align: a tremor may have a non-muscular origin (for example, caused by cardio-ballistic effects) and detecting this provides meaningful clues to the diagnosis (in this case, it would point to a physiological tremor).

Standard measurements:

- Tremor at rest (preferably lying down on a bed), during posturing, during actions, sometimes during standing (orthostatic tremor)
- Tremor under specific conditions (cognitive co-activation, motor co-activation)
- Tremor during loading of the limb (with 500 gr)
- Tremor during ballistic movements with the tremulous limb and with another limb
- (Add-on: coherence between two concurrent tremors)
Interpretation.

When interpreting the results of a neurophysiological assessment, the clinical impression during the assessment is often very important. Scientific research that has investigated the sensitivity and specificity of neurophysiological assessments has been hampered by the lack of a clear gold standard for many tremor types (such as ET or tremor in dystonia). In many studies, the clinical impression after follow-up or after the neurophysiological tremor assessment was taken as the gold standard, which may have the risk of circularity. Nevertheless, below are some clues that may be helpful. For two good overview papers, see 6,7.

Signs of peripheral tremor 5:

- Tremor is confined to accelerometry (no EMG bursts)
- Tremor frequency is reduced with loading of the limb (i.e. adding a 500 g weight)
- Tremor frequency depends on the length of the reflex arc (e.g. higher in the finger than in the hand)

Signs of enhanced physiological tremor 7:

Same as outlined above (>90% of enhanced physiological tremors have a peripheral origin)
- Frequency > 6 Hz
- Tremor variability (usually >1.75 Hz)

Signs of psychogenic tremor 8:

- Entrainment of the tremor rhythm during a rhythmic voluntary movement of another limb (which is preferably done at a non-
harmonic frequency, such as 3 Hz tapping in a patient with a 5 Hz tremor)

- **Distractibility** (i.e. the tremor goes away when the subject performs mental arithmetic, or the subject is extremely bad at performing the task at hand)

- Extreme **variability** of tremor frequency (usually > 1.75 Hz)

- Pause or >50% reduction in tremor amplitude during a ballistic movement of the contralateral limb (positive *pointing test*)

- **Coherence** of bilateral tremors (suggesting a common oscillator, in this case the voluntary motor system)

- Increased tremor **amplitude** during loading of the limb

**Signs of ET**[^3][^4]:

- **Rhythmic bursts** of postural tremor on EMG (i.e. not of peripheral origin)

- Tremor **frequency** greater than or equal to 4 Hz

- **Rest tremor absent** or, if present, frequency 1.5 Hz lower with respect to the postural tremor

- Absence of **latency** from rest to postural position (which would rather fit with Parkinson’s tremor)

- Changes of the dominant frequency peak less or equal to 1 Hz after the **weight load** test (i.e. not of peripheral origin).

- Presence of **intention** tremor (a tremor that is of maximum amplitude when reaching the target, e.g. the tip of the nose)


Signs of the classical Parkinson’s tremor\textsuperscript{10}:

- *Asymmetric* resting tremor of the limb at a frequency of 4-6 Hz

- *Pill-rolling* aspect

- Transient (>2 sec) *suppression* of tremor amplitude during a voluntary movement with the trembling arm

- *Increase* in tremor amplitude during cognitive co-activation (serial sevens) or motor co-activation with another limb (e.g. tapping with the contralateral hand, or walking)
References and suggested reading:


