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Tremor Analysis Using Surface Electromyography: Is It Required?

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Abstract

Objective: In this study, we aimed to compare the role of clinical examination and the contribution of surface electromyography in a population of patients with tremor.

Methods: We retrospectively evaluated the medical records of patients who underwent surface electromyography with a preliminary diagnosis of tremor between 2010 and 2022. We retrieved the demographic data and referring specialty (general neurology, movement disorder specialist, non-neurology department) from records. We reclassified phenomenology and underlying etiology according to the latest revision of the Movement Disorders Society classification. We re-evaluated the findings in surface electromyography.

Results: Based on clinical examination, 130 patients (63 women, aged 6-82 years, mean age: 39.7 years) had the phenomenological diagnosis of tremor. Surface electromyography changed the tremor diagnosis in 67 (51.5%) of the patients. The diagnoses of essential tremor, epilepsy, and anti-seizure medication-induced tremor, tremor related to metabolic disease, and drug-induced tremor were changed in 3 patients, 6 patients, 5 patients, and 1 patient, respectively. The discrepancy between clinical and surface electromyography was seen in 11.5% of the cases. This discrepancy was infrequent among movement disorder specialists (20%) compared to non-neurology branches (40%) and general neurology (40%) (P = .007).

Conclusion: As seen in our study, tremor and myoclonus may have similar clinical features in some cases, especially for relatively inexperienced clinicians. Surface electromyography provides the differential diagnosis of tremor and myoclonus. Surface electromyography may be recommended to distinguish between tremor and myoclonus, to identify specific tremor subtypes such as functional tremor, and to identify myoclonus subtypes.

Keywords: Polymyography, surface electromyography, tremor, myoclonus

Introduction

Electrophysiological assessments have proven to be beneficial in diagnosing patients with movement disorders. These assessments are critical as they provide clinical information to identify the correct diagnosis. The results of electrophysiological assessments can also be used to evaluate treatment efficacy.[1] The main electrophysiological techniques for assessing myoclonus and tremor are surface electromyography (sEMG), electroencephalography (EEG), and accelerometry. Additional assessment methods include recording long-latency reflex and stimulation by transcranial magnetic stimulation.[1-3]

Tremor is the most common movement disorder in adults. It is an involuntary and rhythmic movement of any body part.[4,5] In addition to a detailed history, it is crucial to determine the topographic distribution, frequency, and relation of tremor with movement and posture to direct the etiology diagnosis.[5-7] The electrophysiological analysis can be valuable in assessing patients with hand tremor.[2] Neurological examination may provide information regarding amplitude and activation conditions triggering tremor; however, determining their frequency and rhythm may require clinical expertise. In a study, the clinical accuracy of diagnosing essential tremor was 63%.[8] Distinguishing between tremor and myoclonus is another issue, and electrophysiological analysis is vital in assisting in the differential diagnosis of myoclonus and tremor.[1] Myoclonus is the sudden, short, jerky involuntary movement that occurs as a result of muscle contraction (positive) or inhibition (negative) of contraction and can be observed in the extremities, face, and trunk.[9] However, sometimes, it may create a semi-rhythmic involuntary movement enough to produce visible and palpable movements at the joints when the hands are extended. This is a specific type of myoclonus, minipolymyoclonus, an intermittent, involuntary movement that involves only fingers or, more rarely, the entire hand at the beginning of a posture or movement.[10]

The necessary equipment for tremor analysis includes two-one-axis accelerometers and a 4-channel sEMG.[2] The tremor in the hand is measured at rest, in different positions with and without weight loading, and during movement,[2] distractibility, and entrainment.[11] The signals captured are analyzed in both the time and frequency domains.

This study aims to conduct a retrospective analysis of the clinical characteristics and ultimate diagnoses of patients admitted with tremor. The main objective of this study is to respond to the study question, "Is surface electromyography required to diagnose tremor?" and to assess the effectiveness of sEMG in diagnosing tremor compared to clinical examinations.

Methods

Patients

All medical recordings performed between 2010 and 2022 for the assessment of involuntary movements in our electrophysiology

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department were retrospectively analyzed. Since it was a retrospective study, informed consent was not obtained. The research study was conducted in compliance with the Declaration of Helsinki and was approved by the İstanbul University-Cerrahpaşa Ethics Committee (Approval no: E-83045809-604.01.01-649700, Date: March 22, 2023). A single neurophysiologist (MEK) performed all the recordings, and 2 neurophysiologists (MEK, AG) reviewed them. We were able to identify individuals who were hospitalized with a preliminary diagnosis of hand tremor based on these recordings. There was no age limit. We included all patients with any tremor diagnosis. The exclusion criteria were limited information regarding clinical or etiological findings or a lack of a final diagnosis.

Clinical Diagnosis and Evaluation

We used the attending physician's clinical diagnosis as the first diagnosis. The clinical diagnosis was classified according to the previous reports.[5] The gold standard diagnosis was the final clinical diagnosis after sEMG and, in some cases, imaging or laboratory testing. From the clinical records, we recorded: age, sex, primary pre-polymyography diagnosis, and the final clinical diagnosis. Clinical data included age at examination, age at onset, sex, and referring specialty (general neurology, movement disorder specialist, or non-neurology department).

Electrophysiological Evaluation

Electrophysiological studies were done using AgAgCl sEMG recording electrodes (Neuropack ΣMEB5504K, Nihon Kohden Corporation, Tokyo, Japan) according to standard techniques. These tests included sEMG of appropriate muscles (maximum 8 channels depending on the clinical results). Tremor and myoclonus were determined according to previous reports.[2,6,11] We measured tremor at rest, in different positions with and without weight loading, and during movement, distractibility, and entrainment.[2,11]

Briefly, we performed the following conditions after observing patients at rest. First, the arm was held in a posture. Depending on the patient's strength, a single 500 g weight was used to achieve arm loading. We documented any changes in tremor frequency (>1 Hz) or amplitude after loading. We examined entrainment by having patients hold their most affected hand in a position that caused the tremor most while instructing them to imitate tapping with their less affected hand at the same speed as the physician. The test was considered positive when there was a tremor frequency shift (decrease >1 Hz) or temporary tremor suppression. To assess distractibility, patients were asked to count months backward while holding their hands in a position that evoked maximal tremor. Fine motor skills were tested by having patients hold a small cup and move it toward their mouth.

Statistical Analysis

Mean age, gender, etiology, main clinical findings, and referring specialty were compared. The Statistical Package for Social Sciences version 20.0 software (IBM Corp.; Armonk, NY, USA) was used for data analysis.

Results

During the study period, 130 patients met the inclusion criteria and were included in the study.

Clinical Findings

There were 63 women. The mean age was 39.7 ± 23.1 years (min-max: 6-82 years). The first diagnoses based on clinical examination included essential tremor (n = 47), drug-induced tremor (n = 47), tremor related to metabolic disease (n = 32), functional tremor (n = 2), and parkinsonism tremor (n = 2). The group with drug-induced tremor included patients with anti-seizure drug-induced tremor (n = 45) and lithium-induced tremor (n = 2). Patients were referred by a movement disorder specialist (n = 47, 36%), by a general neurologist (n = 46, 35%), or from non-neurology departments (n = 37, 29%).

Electrophysiological Findings

Surface electromyography revealed that 63 (48.5%) patients had only tremor, 52 (40%) had both tremor and myoclonus, and 15 (11.5%) had only myoclonus. The majority of the latter group consisted of patients referred from non-neurology departments.

The phenomenology based on the clinical examination and sEMG was changed in 67 (51.5%). Diagnoses after electrophysiology based on clinical examination and sEMG were changed in 15 (11.5%) patients (Figure 1).

The diagnoses of essential tremor, anti-seizure medication-induced tremor, and tremor related to metabolic disease were changed in 3, 7, and 5 cases, respectively. In the case of essential tremor, the diagnosis was changed because electrophysiological analysis disclosed myoclonus, not tremor. In the case of anti-seizure medication-induced tremor, the diagnosis was changed to myoclonus attributed to epilepsy or medication-related myoclonus.

A discrepancy between clinical and surface electromyography was seen in 11.5% of the cases. This discrepancy was infrequent among movement disorder specialists (20%) compared to non-neurology branches (40%) and general neurology (40%, *P* = .007).

Discussion

The significant finding of our study was the discrepancy between clinical examination and surface electromyography in 11.5% of the cases. In an additional 40% of patients, myoclonus was easily overlooked in the presence of tremor. A previous study reported that the diagnosis was changed in 37% of the cases.[12] Therefore, polymyography is needed to confirm the diagnosis. In our study, while the diagnosis of polymyography supported the preliminary diagnosis of clinical tremor in most cases, the diagnosis was changed in 11.5% of the cases (in favor of myoclonus). The reason for such a low rate of misdiagnosis compared to previous reports is the referral of most patients by experienced neurologists (or movement disorder specialists) in a tertiary hospital setting. Even under these circumstances, accompanying myoclonus would have easily been overlooked just by clinical examination.

Thus, the response to the study question, "Is surface electromyography required to diagnose tremor?" is *Yes*. Our results suggest that it is helpful in patients with tremor.

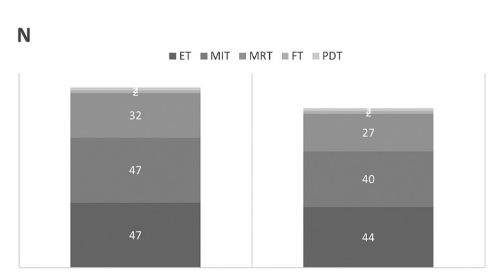

Figure 1. Discrepancy between clinical and surface electromyography was seen in 11.5% of the cases. This discrepancy was infrequent among movement disorder specialists (20%) compared to non-neurology branches (40%) and general neurology (40%, *P* = .007).

The first question in the electrophysiology laboratory is, "Is this tremor?" A tremor is an involuntary, rhythmic, oscillatory movement of a body part.[5] In particular, tremor and myoclonus may have similar clinical features. For example, sEMG provides distinction if there is a minipolymyoclonus mimicking tremor. The second question to the electromyographer covers tremor characteristics: regularity, frequency, and amplitude. The analysis typically includes the amplitude, frequency, and burst lengths of sEMG signals from the agonist and antagonist muscles.[13]

These characteristics are best identified by sEMG and accelerometer.[14] Muscle activity is noninvasively monitored over the skin in sEMG research. Typically, a tendon-belly configuration links the active and reference electrodes to the target muscle. The active and reference electrodes can be positioned on the muscular belly, around 2 cm apart for larger muscle groups. Electrophysiological studies show a reciprocal contraction pattern between the agonist and antagonist muscles and a bilateral posture/action tremor in ET,[9,15] a centrally generated tremor. It has a frequency between 4 and 12 Hz. Its frequency changes by less than 1.75 Hz during loading or the course of recording. At rest, the tremor is frequently absent or, if present, has a frequency that is 1.5 Hz lower than the postural tremor and does not have a tremor latency.[11] The EMG discharge of cortical or cortico-subcortical myoclonus typically lasts 100 ms or less and rarely more than 250 ms. Synchronous agonistic and antagonistic bursts are characteristic of myoclonus. A paroxysmal cessation of tonic EMG activity can be used to identify negative myoclonus. Tremor causes regular EMG signals with a specific main frequency, while the frequency distribution in myoclonus is irregular.[9] These are the main features that help us to identify tremor and myoclonus during sEMG.

There are additional contributions of sEMG in understanding movement disorders besides unbiased, repeatable, and diagnostic information: (1) physicians can be informed about the presence of mechanical, mechanical-reflex, or central tremor components, and (2) physicians can distinguish between oscillators of tremor.[16]

Researchers suggest recording at least 30 seconds at baseline for limb tremors before task evaluations. The subject should have rest periods, hold particular positions, and, if necessary, complete particular movement activities throughout tremor examinations. It is advised that the recordings for each test last at least 20 seconds and be played again at least once. If complex tremors are present, studies advise recording EMG signals from both agonist and antagonist muscles and distal and proximal muscle groups to capture the tremor pattern. The main parameters analyzed are the rhythmicity of EMG bursts, burst length, temporospatial organization of contraction among involved muscles, and activation tests (mental activation, action, distraction, voluntary control).[11,17]

The electrophysiological characteristics can provide the clinician with invaluable information that cannot be obtained from a physical examination and facilitate the diagnosis and treatment approach of the patients to be followed. Additionally, most of the equipment required for recordings is available in many clinical electrophysiology laboratories and at a relatively low cost, which may facilitate its use in a clinical setting.

The main limitation of our study is its retrospective nature. The neurophysiological criteria we used have been described in the previous literature,[6,14] but our findings need to be supported together with a clinical diagnosis. The strength of this study was the inclusion of a general tremor population and not an isolated group such as essential tremor or Parkinson's tremor.

The practical use of these approaches should be a resource available to neurologists working in movement disorders to increase the diagnostic precision of tremors. However, we should emphasize that tremor analysis is supplementary to the history and physical exam, and a detailed clinical examination should be performed first.

Availability of Data and Materials: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: This research study was conducted in compliance with the Declaration of Helsinki and was approved by the İstanbul University-Cerrahpaşa Ethics Committee (Approval no: E-83045809-604.01.01-649700, Date: March 22, 2023).

Informed Consent: Since it was a retrospective study, informed consent was not obtained.

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