Induction of seizures due to cortical hyperexcitability during a podiatric physical examination in an epileptic patient: A case report

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Epilepsy is a neurological disorder affecting the central nervous system and is characterized by recurrent and unprovoked seizures. Seizures often occur due to cortical hyperexcitability because of inappropriate sensory, cognitive, and reflex stimuli. Epilepsy has numerous etiologies, each related to an underlying central nervous system dysfunction. Focal seizures are limited to a single cerebral hemisphere, whereas general seizures involve both hemispheres. Literature review has shown the use of transcranial magnetic stimulation for inciting epileptic seizures, as well as the use of a tuning fork to elicit non-epileptic seizures (NES). However, minimal research exists demonstrating the use of a 128-Hz tuning fork to induce epileptic seizures. Clinical symptoms of psychogenic non-epileptic seizures (PNES) and epileptic seizures are very similar to the untrained eye and without the assistance of an EEG, one cannot distinguish the two. We report a case in which a 71-year-old female experienced symptoms consistent with an “aura” or onset of a seizure when subjected to an examination of vibratory sensation to the left medial malleolus during a general podiatric examination. The patient’s past medical history includes partial symptomatic epilepsy with complex partial seizures in addition to NES. The authors agree that it is imperative to practice with caution when conducting a general podiatric examination on a patient who is predisposed to epileptic activity, as the threshold for an induction of a seizure may be lowered.

Keywords: epilepsy, seizures, tuning fork, podiatric physical exam

A 71-year-old African American female presented for care of onychomycosis of toenails bilaterally. She stated she was unable to care for her feet due to severe arthritis of the right upper extremity. The patient’s pertinent medical history included a history of partial symptomatic epilepsy with complex partial seizures without status epilepticus. She acknowledged the condition dating back to when she was 6 years of age and a family history of epilepsy in maternal and paternal cousins and aunts. Her other medical conditions consisted of arthritis of the right upper extremity and a history of pulmonary embolisms, both under appropriate medical management.

On physical exam, the patient’s vascular and muscular status was intact without deficits. Neurological examination with a 5.07 10-g monofilament revealed no response bilaterally to the feet on dermatomes L4, L5, and S1. Proprioception of the right hallux was intact; however, the patient was unaware of the position of the left hallux during testing. On examination using a 128-Hz tuning fork, vibratory sensation was not intact on the L5 dermatome of the right and left 1st metatarsophalangeal joints but was intact at the L4 dermatome of the right median malleolus. A severe physical reaction was elicited from the patient when the 128-Hz tuning fork was tested at the L4 dermatome of the left medial malleolus. Within approximately 10 seconds of application of the tuning fork to the left medial malleolus, the patient jolted out of a relaxed seated position in the clinical examination chair, to an upright position raising and shaking both of her arms. At this response, the examiner immediately removed the stimulus and switched to checking the patient for alertness and awareness.
Patient returned to the chair and stated she felt the vibrations climbing up her left leg and anticipated the onset of a seizure. She felt light-headed after the incident and requested a glass of water.

She also stated she had never received this specific vibratory test prior and was unaware of this response prior. The rest of the care proceeded as normal, and the patient was reappointed for us at her regularly scheduled time but was asked to see her primary care physician (PCP) regarding this incident.

At the next follow-up visit 12 weeks later, the patient stated that she had a seizure later in the week after her prior visit. The patient’s PCP had sent her last EEG study done earlier in the year suggesting evidence of NES. The first event was of a 7-minute duration, the patient was not alert and awake and showed asynchronous arm movements. The second event was 7 minutes and 12 seconds, the patient was awake without speech, experienced right arm shaking, and was interactive with the PCP. The conclusion of the test suggested that the patient had self-protective and anticipatory behaviors.

Discussion

Epilepsy is clinically defined as having two unprovoked seizures occurring more than 24 hours apart or a single unprovoked seizure if the recurrence risk is categorized as “high” (>60% over the next 10 years) [1]. Seizures are classified into two main categories, partial and generalized. Partial seizures are further divided into simple or complex seizures, distinguished by the presence or absence of the impairment of consciousness, where simple seizures do not have an impairment and complex have the impairment. Partial seizures can present variably depending on which part of the cerebral cortex is involved in the ictal discharge and whether it spreads unilaterally or bilaterally to other cortical regions. These can result in motor, autonomic, somatosensory, special sensory, or psychic symptoms. Simple partial motor seizures present with clonic activity of the contralateral limb or the face, whereas focal seizures can present with speech arrest or vocalization. Autonomic symptoms of seizures consist of vomiting, sweating, piloerection, pupil dilation, pallor, flushing, borborygmi, and/or incontinence [2].

The term, “aura”, is synonymous with a simple partial sensory or psychic seizure [2]. It is also used to describe the patient’s symptoms that suggest the onset of a seizure such as a prodrome [3]. An aura can be of different types including, sensory hallucinations, light-headedness, déjà vu sensation, abnormal taste, or an indescribable sensation. Somatosensory auras are numbness or tingling sensations in the face or extremities. As the epileptiform discharge ascends the homunculus of the primary sensory cortex, within the central gyrus, sometimes the sensation can travel between the arms, legs, and face. Auras originating from epileptiform discharges within the supplementary motor cortex can cause bilateral sensation in the distal extremities or trunk, with sequential feelings of muscle tightness or stiffness.

Although most times an aura is followed by a seizure, sometimes the aura is an isolated event with no subsequent seizure. Mental status is not altered during an aura; the patient is quite aware of their surroundings. The duration of an aura can be anywhere from less than 30 seconds to more than 5 minutes [4].

Complex partial seizures usually originate in the frontal or temporal lobes of the brain but can occur in parietal or occipital lobes as well. Complex partial seizures may start as simple partial seizures (auras) and progress to complex seizures or they may begin as complex. The most common partial epilepsy is temporal lobe seizures, which often begin with an aura. The auras include viscerosensory symptoms, sensory illusions, or hallucinations. The ictal event is characterized by a blank stare, loss of contact with the environment, orolaryngeal automatisms, hand automatisms, upper limb tonic or dystonic posturing, and/or early head or eye deviation [2].

Seizures are very common and have a variety of causes. At least 10% of the population will have a seizure at some point in their lifetimes. These can occur due to an acute insult to the CNS, because of chronic structural or functional disturbances in the cerebral cortex, due to genetic disorders, or may not have an identifiable underlying etiology [5].

Epilepsy is diagnosed clinically by taking a thorough history from the patient and patient’s family members. The only way to identify epilepsy is through EEG recording during a seizure but this is not done during a routine outpatient procedure. Epileptics will present with normal neurologic examinations whereas patients with partial seizures will have an abnormal neurologic exam. EEG and neuroimaging are the standard of care for evaluating partial epilepsy.
EEG is the single most informative tool for partial epilepsy, however they might not be the sole, plausible method to make a diagnosis because spikes are more active at night. Furthermore, some of the spikes are also common in non-epileptics. Therefore, it is important to use clinical history in making the diagnosis [6].

Thorough literature review did not reveal any studies on induction of epileptic seizures through the use of tuning forks nor any on magnetic stimulation on the extremities. However, there is research showing induction of seizures through transcranial magnetic stimulation. In a study by Hufnagel and associates, 13 patients who were medically diagnosed with intractable complex partial seizures were subjected to different amounts of transcranial magnetic stimulation. Subdurally implanted electrodes revealed that the stimuli were able to elicit epileptiform discharges in 12 of the 13 patients [7]. Another case report showed transcranial magnetic stimulation of 2 Tesla pulsed for 100 ms at a variety of intervals, induced a generalized tonic clonic seizure in the subject [8]. A Harvard review on the safety and tolerability of repetitive transcranial magnetic stimulation in patients with epilepsy, analyzing publications from January 1990 to August 2015, determined that 18.3% of subjects reported adverse events after stimulation. 85% of these events were mild with headaches or dizziness being the major complaint. Furthermore, their analysis showed 2.9% of the subjects reported seizures [9]. Although the induction of a seizure through magnetic stimulation of nerves of the lower extremity has not yet been reported in literature, further research and data could provide better insight on the possibility of this correlation.

Although seizures are thought to be neurological in origin, a psychogenic condition does exist that portrays similar clinical symptoms. The authors of this article believe that psychogenic non-epileptic seizures (PNES) are important to note as they can be a differential diagnosis considering PNES resemble epileptic seizures in terms of movement, sensation, or experience. The origin of PNES is believed to stem from physiological or psychological distress. Differentiating PNES from epileptic seizures usually requires EEG monitoring as the former doesn’t have associated EEG readings [10]. However, PNES can coincide with epileptic seizures and may be witnessed in patients diagnosed with epilepsy. In a study by Goyal et al., multiple methods of provoking PNES were compared according to sensitivity and specificity. The experimental group was of PNES patients and the control group of patients with epilepsy. Of these methods, a 126 Hz tuning fork was applied to the vertex for 15 seconds with a maximum of 3 attempts. Seizures were precipitated through these methods in the experimental group but not in the control group. The control group, however, did have symptoms of light-headedness, uneasiness, and palpitation. Results revealed tuning fork application to have a high sensitivity (61.4%) and specificity (100%) and required the least amount of time (8.2 ± 1.9 s) to induce compared to other methods [11].

Conclusion

A thorough literature search provides no specific incitement regarding the rate of incidence, specific mechanism, or rate of occurrence to explain the clinical observations of the above presented case. After completing a thorough history and physical in addition to evaluating the clinical signs, symptoms, and overall presentation, it is likely that the events outlined above are consistent with the findings to suggest a diagnosis of an aura or nonepileptic seizure. To be certain of the diagnosis of an aura or nonepileptic seizure, an EEG would have had to be done during the event in addition to using sound clinical judgment based upon the findings from a physical exam conducted by a physician best suited for this matter.

A literature review, however, does support the possibility of a tuning fork inciting epilepticus in a patient with such medical history. Given the somatosensory symptoms, light-headedness, and clonic activity of the upper limbs, an “aura” or simple partial sensory seizure could have taken place during our office visit. The patient's mental status was not altered, and it did not last more than a few seconds at most. As is common with simple partial seizures, the patient had described feelings of vibrations ascending up her leg. Due to ethical concerns it is difficult to replicate the findings for the purpose of experimentation, further research on this subject may not be possible and therefore a clear diagnosis of the events that unfolded cannot be elucidated.
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References