A 50-year-old female underwent a sleep study for suspected sleep apnea. She reported a history of snoring and mild daytime sleepiness. The patient denied a history of symptoms consistent with the restless legs syndrome. Her husband reported that her feet sometimes moved rhythmically at night (bedcovers moved) although she appeared to be asleep.

Physical examination: unremarkable except for obesity and Mallampati 2 oropharynx

Polysomnography: Three 30-sec tracings (Figures 1, 2, 3).

Question: What phenomena are illustrated?

Figure 1—A 30-sec tracing showing frontal, central, and occipital EEG derivations; left and right electrooculographic derivations; chin electromyography; an electrocardiographic tracing; nasal pressure, airflow (nasal-oral thermal device); chest and abdominal movement; right and left anterior tibialis (RAT, LAT) electromyographic tracings; and pulse oximetry.
Hypnagogic foot tremor, alternating leg muscle activation, and fragmentary myoclonus

Hypnagogic foot tremor (HFT) was first described by Broughton in 1988 as a coarse tremor of one or both feet occurring with sleep onset. Wichniak et al investigated 375 consecutive patients undergoing polysomnography and found rhythmic foot movements in 7.5%. They found the movements to be most common in pre-sleep wakefulness with some persistence into stages N1 and N2. The authors also found HFT in 5% of a healthy control group of 20 subjects. The EMG bursts of HFT can involve one or both feet and are often seen following arousals in some patients. The AASM scoring manual lists the following criteria for a diagnosis of HFT: (1) the minimum number of bursts needed to make a train of bursts in hypnagogic foot tremor is 4 bursts, (2) The minimum frequency of the EMG bursts in HFT is 0.3 Hz, (3) The maximum frequency of the EMG bursts in HFT is 4.0 Hz. The scoring manual also notes that the duration of HFT bursts is 250–1000 msec. The HFT frequency range of 0.3 to 4 Hz corresponds to a range of 0.25 to 3.33 seconds between the onsets of consecutive EMG bursts. In contrast, the range of time between the onsets of

Figure 2—A 30-sec tracing showing frontal, central, and occipital EEG derivations; left and right electrooculographic derivations; chin electromyography; an electrocardiographic tracing; nasal pressure, airflow (nasal-oral thermal device); chest and abdominal movement; right and left anterior tibialis (RAT, LAT) electromyographic tracings; and pulse oximetry.

Figure 3—A 30-sec tracing showing frontal, central, and occipital EEG derivations; left and right electrooculographic derivations; chin electromyography; an electrocardiographic tracing; nasal pressure, airflow (nasal-oral thermal device); chest and abdominal movement; right and left anterior tibialis (RAT, LAT) electromyographic tracings; and pulse oximetry.
consecutive leg movements in a series of periodic limb movement in sleep (PLMS) is 5 to 90 seconds. HFT is generally considered a benign phenomenon and no treatment is usually necessary.2,3,4

Alternating leg muscle activity (ALMA) was first described by Chervin and coworkers.5 They identified 16 cases after a review of 1500 studies. Ten of the patients with ALMA had a periodic limb movement index >5/hr. Twelve of the patients with ALMA were taking antidepressant medication. The phenomenon was noted in all sleep stages but particularly following arousal. ALMA has a pattern similar to HFT, except successive bursts alternate between the legs. The AASM scoring manual5 states that the following rules define ALMA: (1) The minimum number of discrete and alternating bursts of leg muscle activity needed to score ALMA is 4 bursts, (2) the minimum frequency of the alternating EMG bursts in ALMA is 0.5 Hz, (3) the maximum frequency of the alternating bursts in ALMA is 3.0 Hz. The scoring manual notes that the usual range for duration of ALMA EMG bursts is 100–500 msec. The ALMA burst frequency range of 0.5 to 3 Hz corresponds to a range of 0.33 to 2 sec between the onsets of consecutive EMG bursts. It is of interest that periodic limb movements can also alternate between legs,7 and for this reason EMG monitoring of both anterior tibialis muscles is recommended.8,9 ALMA is thought to be a benign phenomenon, and some consider it to be a variant of HFT.

Fragmentary myoclonus (FM) is characterized by recurrent and very brief (75–150 msec) EMG bursts occurring asynchronously and asymmetrically in a sustained manner without clustering.3,4,5 The appearance of the leg EMG in FM resembles the phasic EMG twitches (transient muscle activity) that are a normal finding in REM sleep. However, the pattern of FM differs from the typical transient muscle activity of REM sleep as the FM EMG bursts are not clustered but spread more evenly across epochs in which FM is present. FM may be present in wake, NREM, and REM sleep in some patients. The associated movements are very small and consist of twitching of the fingers, toes, or corners of the mouth.4,5 Sometimes no movement is visible and the pattern is simply observed in the leg EMG tracings. The AASM scoring manual5 defines criteria for excessive fragmentary myoclonus (EFM): (1) the usual maximal EMG burst is 150 msec, (2) at least 20 minutes of NREM sleep with FM must be recorded, (3) at least 5 EMG potentials per minute must be recorded. The scoring manual also states that gross motor jerks of extremities are not observed during EFM activity. Instead, either no movement or small twitch-like movements of finger, toes, or corner of the mouth may be observed. EFM is felt to be benign and does not require further evaluation or treatment.

In the current patient, an epoch of stage W (wake) is shown in Figure 1 with a pattern of EMG bursts in the left leg consistent with HFT. The frequency is approximately 0.6 Hz. Later in the night the leg EMG pattern shown in Figure 2 was noted. This 30-sec epoch of stage W shows a pattern consistent with ALMA although the duration of the bursts is somewhat longer than typically seen. The frequency of bursts is approximately 0.55 Hz. Figure 3 shows a leg EMG pattern consistent with fragmentary myoclonus occurring during Stage N2. However, this leg EMG pattern was present for less than 20 min of NREM sleep and therefore would not meet criteria for excessive fragmentary myoclonus. Of interest the patient also had leg movements meeting criteria for periodic limb movements in sleep (PLMS index was 10/hour).

**REFERENCES:**


**CLINICAL PEARLS**

1. Hypnagogic foot tremor (HFT) is a form of rhythmic foot movement in which leg EMG bursts occur at a higher frequency (0.3 to 4 Hz) than periodic limb movements in sleep. At least 4 EMG bursts must be present for a train of bursts to be considered HFT.
2. HFT is usually noted in pre-sleep wakefulness or at transitions between wake and stage N1 or N2.
3. Alternating leg movement activity (ALMA) is similar to HFT except that the EMG bursts alternate between legs. The frequency range is 0.5 to 3 Hz, and the burst duration is typically 100-500 msec.
4. ALMA also occurs at transitions between wake and sleep and may follow arousals in some patients.
5. Excessive fragmentary myoclonus (EFM) is present when a pattern of repetitive brief (<150 msec) bursts of leg EMG activity are present for at least 20 min of NREM sleep at a rate of at least 5 bursts/min.
6. HFT, ALMA, and EFM are felt to be benign phenomena that require no treatment.