This section deals with a group of waveforms that may mimic abnormal waves but have now been recognized as normal variants. By definition, a normal variant is not associated with disease, be it epilepsy or another abnormal state. A few of the waveforms discussed in this chapter are of uncertain clinical significance: they are known to occur frequently in normal individuals but may be seen more often in people with epilepsy.

Many of the normal variant patterns described here bear some resemblance to epileptiform activity. The importance of developing proficiency in recognizing these patterns is to avoid mistaking them for epileptiform abnormalities. The basic features of these normal variants should be committed to memory so as to avoid the pitfall of describing one of these variants as an epileptiform abnormality (Table 11-1).

NORMAL VARIANTS THAT MIMIC SINGLE EPILEPTIFORM WAVES

Posterior Occipital Sharp Transients of Sleep

Posterior occipital sharp transients of sleep (POSTS) are one of the most common normal variants seen in the EEG and can be considered one of the normal elements of sleep. The acronym POSTS tells the story of these distinctive waveforms: POSTS are of Positive polarity, they are seen in the Occipital areas; they have a Sharp Transient waveform, and they occur in Sleep. POSTS are “triangular” or V-shaped wave that are particularly prominent in light sleep (see Figures 11-1 and 11-2). If not recognized as POSTS, these low-voltage discharges could potentially be mistaken for occipital sharp waves. Because POSTS are so common, the polarity of any low-to medium-voltage occipital sharp wave seen in sleep should be assessed before deciding that it is abnormal. Displaying POSTS in an appropriate referential montage should confirm their positive polarity and correctly identify them as POSTS rather than epileptiform discharges. POSTS usually appear in a bilaterally synchronous fashion, although normal POSTS may manifest asymmetrical amplitudes. POSTS may occur in brief, semirhythmic runs. Although POSTS usually consist of low-voltage, V-shaped waves, they may occasionally assume a more spiky appearance (see Figure 11-3).

Lambda Waves

Lambda waves are discussed with POSTS because their morphology and location are similar. The two are easily distinguished because lambda waves occur exclusively

<table>
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<th>Summary Table of Selected Normal Variants</th>
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<td><strong>Posterior Occipital Sharp Transients of Sleep</strong></td>
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<tr>
<td><strong>Lambda Waves</strong></td>
<td>Low-voltage occipital sharps during wakefulness associated with searching eye movements</td>
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<td><strong>Small Sharp Spikes/Benign Epileptiform Transients of Sleep</strong></td>
<td>Low-voltage temporal spikes, synchronous or independent, unilateral or bilateral, with broad field seen in adults during drowsiness and light sleep</td>
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<td><strong>Mu Rhythms</strong></td>
<td>Arch-shaped rhythm in central areas during wakefulness, suppresses with contralateral hand movement</td>
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<tr>
<td><strong>14- and 6-Hz Positive Bursts</strong></td>
<td>Medium- to high-voltage, positive-polarity, arch-shaped bursts during drowsiness and light sleep in posterior temporal and occipital areas, mostly in children</td>
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<tr>
<td><strong>Wicket Spikes/Wicket Rhythms</strong></td>
<td>Arch-shaped rhythm of temporal areas during drowsiness and light sleep, mostly in adults</td>
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<td><strong>Breach Rhythms</strong></td>
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<tr>
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<tr>
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</tr>
<tr>
<td><strong>Posterior Slow Waves of Youth</strong></td>
<td>Theta and delta waves intermixed with posterior rhythm until mid-teenage years</td>
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</tbody>
</table>

FOLD, Female whose pattern has an Occipital emphasis, Low in amplitude, and seen in the Drowsy record; WHAM, Waking record, High in amplitude, Anterior in location and especially in Males.
Lambda waves also appear as low-voltage triangular waves in the occipital areas, reminiscent of the Greek letter λ, but they are distinctive in that they occur at the time of lateral searching eye movements. Confirmation that a low-voltage occipital sharp transient wave is a lambda wave is made easier by finding evidence of concurrent lateral eye movement artifact. Lambda waves may be either surface positive or surface negative in the occipital area (see Figure 11-4). They are not as common as POSTS and are seen more frequently in children than in adults. Because they are related to searching eye movements, lambda waves are generally seen when the patient’s eyes are open and the posterior rhythm is suppressed. Voltage asymmetry of lambda waves is not necessarily considered abnormal.

**Small Sharp Spikes and Benign Epileptiform Transients of Sleep**

The terms small sharp spikes (SSS) and benign epileptiform transients of sleep (BETS) are synonymous. These quick, low-voltage spikes are usually seen in the temporal areas with a broad gradient across the temporal chain. The upward and downward phases of the transients are usually of similar amplitude. They occur...
Figure 11-2. The same page of EEG shown in the previous figure is displayed in a referential montage. The clear downgoing deflections in the O1 and O2 channels (dots) clarify the positive polarity of these occipital discharges and confirm that they are an example of posterior occipital sharp transients of sleep.

Figure 11-3. An example of Stage II sleep is shown in a referential montage (note the sleep spindles in the shaded area). Posterior occipital sharp transients of sleep (POSTS) are seen in the O1 and O2 channels (dots). These POSTS have a more spike-like morphology than those seen in the previous example; the initial downgoing deflections indicate their positive polarity. These occipital waves are not synchronous with the electrocardiogram (EKG) complexes and therefore do not represent EKG artifact.
either unilaterally or bilaterally and, when bilateral, they may occur either synchronously or independently (see Figure 11-5). SSS are seen in drowsiness and light sleep and tend to disappear with deepening sleep. SSS are considered by many to represent a normal variant but some authors still contend that the finding suggests an increased degree of epileptogenicity.

NORMAL VARIANTS THAT MIMIC REPETITIVE EPILEPTIFORM WAVES

Mu Rhythms

Mu rhythms are commonly encountered rhythms seen in the central areas during wakefulness, best recorded by the C3 and C4 electrodes. They are most often seen from later childhood into the adult years, although they are occasionally seen in very young subjects. The mu rhythm has a distinctive arciform (arch-like) or “comb-like” morphology (see Figure 11-6). Because the mu rhythm is suppressed by voluntary motor activity in the opposite hand, the technologist can establish that a sharp central rhythm is a mu rhythm by requesting that the patient move the contralateral hand and demonstrating that the rhythm disappears. Although classically suppressed by moving the contralateral hand, movement of the ipsilateral hand or planning to move the hand may also suppress the mu rhythm in some subjects.

Because this arciform rhythm is sharpened on one side and rounded on the other, there is some potential to mistake it for epileptiform activity. When mu rhythms occur in trains, it is not difficult to identify them correctly on the basis of their location, morphology, and suppression with movement, if necessary. Occasionally, fragments of a mu rhythm may resemble low-voltage spike activity (see Figure 11-7). Apparent low-voltage central spikes can be confirmed to be a mu phenomenon by showing that the morphology of the spike fragment is similar to the mu waves when they occur in trains.

Mu rhythms may be seen either unilaterally or bilaterally. They may suppress independently. Asymmetrical expression of mu rhythms is not considered abnormal. The mu rhythm tends to occur at a frequency similar to that of the patient’s posterior rhythm and therefore, varies with age. In some patients, the posterior rhythm’s field blends into the field of the mu rhythm creating large zones of alpha activity in the posterior quadrants. Because of the similar frequencies and amplitudes of the two rhythms, in such cases, it is not always clear where the posterior rhythm ends and the mu rhythm begins.

The mu rhythm and the posterior rhythm are the two main idling rhythms of the EEG: the mu rhythm is only seen during contralateral motor inactivity and suppresses with movement. Similarly, the posterior rhythm is only present during visual inactivity and suppresses with eye opening or visual attention. A mu-shaped rhythm that does not necessarily suppress

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Figure 11-4 The triangular-shaped waves seen in the occipital channels are examples of lambda waves (dots). Lambda waves are associated with horizontal searching eye movements. Subtle lateral eye movement artifact (arrows) is seen in the frontal/anterior temporal channels with opposite polarity on each side (see Chapter 6, “Artifacts”) for further description of eye movement artifact.)
Wicket Spikes and Wicket Rhythms

Because their morphology is quite similar to that of mu rhythms, wicket rhythms are discussed with mu rhythms. Wicket rhythms differ from mu rhythms in that they are seen in drowsiness and light sleep rather than wakefulness and have a predilection for the temporal rather than the central areas (see Figure 11-8). Their arciform morphology is similar. Wicket rhythms range from 6 to 11 Hz with a voltage range of 60 to 200 µV (Reihler and Lebel, 1977). Similar to the situation seen with mu rhythms, it is possible to mistake a fragment of a wicket rhythm for epileptiform activity rather than a normal variant. Such fragments are called wicket spikes. Wicket spikes are distinct from temporal spike-wave discharges in that there is no aftercoming slow wave and they do not disrupt the underlying rhythm. The confirmation that a temporal spike is a wicket spike is best made by noting that the waveform is similar to that of the spikes when they occur in a train (as a continuous wicket rhythm) found elsewhere in the same tracing.

14- and 6-Hz Positive Bursts

Often referred to simply as “14 and 6,” 14- and 6-Hz positive bursts are seen most frequently in adolescence. The term ctenoids (a word that means shaped like the teeth of a comb or like overlapping fish scales) has also been used for this phenomenon in the past but is no longer the preferred term. As the name implies, two versions of this variant are seen, one firing at a rate of 14 Hz and the other at 6 Hz. The 14-Hz form is more common (see Figures 11-9 through 11-11). The discharges are most prominent in the posterior temporal and occipital areas. The bursts consist of fast, arciform, or comb-shaped rhythmic discharges of low, medium, or high voltage in which the sharp phase has positive polarity and the rounded phase has negative polarity. It was initially asserted that 14 and 6 was associated with a variety of pathologic states, including epilepsy, but these bursts are now classified by most as a normal variant. The 6-Hz version of 14 and 6 is less commonly seen but felt to have the same significance; some patients manifest both forms in the same tracing.

Although 14 and 6 positive bursts may occur bilaterally, they usually do not fire synchronously. Asymmetrical occurrence of 14 and 6 positive bursts is not considered abnormal. Some authors believe that the 6-Hz component of 14 and 6 actually fires at 7 Hz and represents a subharmonic of the fundamental 14-Hz frequency, although true 6-Hz examples are seen. The bursts usually last 1 second or less, and there is no evolution in firing frequency during the burst. The distinctive wave morphology, frequency, and positive polarity help to confirm examples of 14- and 6-Hz positive bursts.
Figure 11-6 A mu rhythm is seen with maximum frequency in the right central (shaded) area, maximum in the C4 electrode. Note the typical morphology of the mu waveform, an arciiform or comblike rhythm, rounded on one side and sharpened on the other.

Figure 11-7 The two low-voltage transients (arrows) taken from the same tracing shown in the previous figure could be mistaken for low-voltage spikes. Comparing these transients to the mu rhythm shown in the previous figure, it becomes evident that these waveforms represent fragments of the patient's mu rhythm.
**Chapter 11  Normal Variants in the Electroencephalogram**

**Figure 11-8** Brief trains of wicket spikes are seen in the left temporal area (arrows). Note the arciform morphology. A lower voltage wicket rhythm is present on the right (bottom four channels).

**Figure 11-9** A close-up of 14 and 6 positive bursts is shown in a referential montage (arrows). Maximum positivity (indicated by downgoing deflections in a referential montage) of the 14-Hz bursts is seen in the left posterior quadrant (P7, T7, O1, and P3 electrodes).

**Breach Rhythms**

A breach rhythm results from a change in the transmission of EEG waves through the area of a skull defect, usually a postsurgical craniotomy site (see Figures 11-12 through 11-14). For reasons that are not fully understood, faster activity is transmitted preferentially through the region of skull defects, causing breach rhythms to have a sharpened appearance. Because the voltage asymmetries caused by breach rhythms could be hard
Practical Approach to Electroencephalography

To interpret without knowledge of the patient’s skull defect, EEG technologists are asked to include information about craniotomy scars along with the clinical history. There is still some question as to whether breach rhythms are simply caused by a reduction in the skull’s insulation effect at sites where it has been surgically disrupted or are instead caused by some change in the underlying cortex caused by the previous surgical procedure. Breach rhythms sometimes bear a resemblance to mu rhythms or wicket rhythms, and some feel that they represent overexpression of these natural rhythms through the skull defect. It is important to identify breach rhythms so as not to misinterpret any observed voltage asymmetry and to avoid mistaking fragments of the breach rhythm for spikes.

**Rhythmic Temporal Theta Bursts of Drowsiness or Psychomotor Variant**

Originally also referred to as rhythmic midtemporal discharges (RMTD), rhythmic temporal theta bursts of drowsiness are also called psychomotor variant because...
of the discharges’ resemblance to a temporal lobe seizure discharge. The use of the original term RMTD may persist because of the ease of using the abbreviation. Rhythmic temporal theta bursts can usually be easily distinguished from seizure discharges in that the frequency, amplitude, and morphology of the waveform do not vary throughout its course (see Figure 11-15). These theta bursts are seen in both children and adults and may be seen in either or both hemispheres. The discharges have a distinctive morphology with trains of waves with rounded tops and sharpened bottoms as seen in the figure. This variant is seen in drowsiness and light sleep and is not felt to be associated with epilepsy.

**Six per Second Spike-Wave Complexes or Phantom Spike and Wave**

Six per second spike-wave complexes are also referred to as “phantom spike wave” because of their short duration, usually 2 seconds or less. Phantom spike and wave is seen in wakefulness and mild drowsiness. The fact that it disappears with deeper sleep helps to distinguish it from epileptiform activity. These discharges

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**Figure 11-11** The same example of 14- and 6-Hz positive bursts from the previous figure is now displayed in a referential montage (arrows). The downgoing spikes in the posterior channels clarify the positive polarity of the bursts and the localization of their field to the left posterior quadrant.
Figure 11-12 A breach rhythm is seen in the right parasagittal area (arrows) after a right-sided craniotomy. Note the higher voltage, sharpened rhythm in the F4-C4, C4-P4, and P4-O2 channels. (Image courtesy of Dr. Edward Bromfield and Dr. Barbara Dworosky.)

Figure 11-13 A breach rhythm is seen in the right midtemporal area (arrow) after a right temporal craniotomy. Note the arcliform nature of the rhythm and compare with the homologous left-sided (T3) electrode. (Image courtesy of Dr. Jong Woo Lee.)
Figure 11-14  A breach rhythm is seen in the left anterior temporal area after a temporal lobectomy in a teenage boy (arrows). Compared with the previous examples, this rhythm has a more sinusoidal appearance.

Figure 11-15  Rhythmic temporal theta bursts of drowsiness, also known as psychomotor variant or RMTD, is seen in each temporal area (arrows). The waves are sharp on one side and rounded or flat-topped on the other. The unchanging morphology and the constant frequency help to distinguish this from a seizure discharge—the “firing rate” is the same during the first second and the last second on the page.
are quick to appear and disappear, and the spike component of the spike and wave may only be intermittently evident.

In 1980, Hughes studied a large group of individuals with six per second spike-wave complexes. In this group, patients with certain characteristics, in particular, those with high amplitude, frontal-maximum discharges, were more likely to have epilepsy. Individuals with lower voltage, posterior discharges were more likely to have been referred for "neurovegetative symptoms" such as headache, dizziness, and vertigo or other psychological complaints as opposed to seizures. He distinguished the two groups using the mnemonics WHAM (Waking record, High in amplitude, Anterior in location and especially in Males) and FOLD (Female whose pattern has an Occipital emphasis, Low in amplitude, and seen in the Drowsy record; see Figure 11-16).

**GENERAL INDICATORS OF NORMAL VARIANTS**

Especially for the beginning EEG reader, memorizing the various characteristics of the normal variants just described may seem a daunting task. Even if all of the normal variant patterns have not been committed to memory, certain features of apparent epileptiform discharges should prompt the reader to question the possibility of a normal variant.

**High Frequencies**

Many of the normal variants have fast firing rates. Whereas “classic” generalized spike wave discharges have a firing rate of 3 Hz and even “fast” spike-wave discharges have a firing rate of 4 to 5 Hz, many of the normal variants have firing rates of 6 Hz or above. Mu rhythms, wicket rhythms,
14 and 6 positive bursts, psychomotor variant, and phantom spike and wave all have firing rates of 6 Hz or higher. Therefore, high-frequency spiking should cause the reader to consider whether the discharge may fit into the group of normal variants. True epileptiform spike-wave discharges occasionally have fast firing rates, but more moderate firing frequencies are more common.

**Monomorphic Rhythms**

The normal variant discharges tend to consist of repetitive waves of similar shape and wavelength (breadth). Because wavelength is directly proportional to frequency, truly monomorphic waves do not vary in frequency. This feature of normal variants helps to distinguish them from seizure discharges and sometimes even from epileptiform activity. A run of the psychomotor variant pattern can be distinguished from seizure activity because it does not vary in frequency even during lengthy trains. In contrast, a hallmark feature of a seizure discharge is a speeding up or slowing down in firing frequency throughout its course. Even interictal polyspike discharges tend to slow down slightly in frequency over the course of a burst, whereas 14- and 6-Hz positive bursts do not. The reader can confirm this by showing that the width (wavelength) of the first wave of a 14-Hz positive burst is the same as the last.

**Disappearance in Deeper Sleep**

The normal variants described earlier appear in wakefulness or drowsiness and light sleep and tend to disappear with deepening sleep. In contrast, epileptiform abnormalities often increase with deeper sleep. Disappearance of a possible epileptiform discharge with deepening sleep should cause the reader to consider whether the discharge in question matches any of the normal variant patterns.

**OTHER NORMAL VARIANTS**

**Posterior Slow Waves of Youth**

Posterior slow waves of youth are theta and delta waves that intermix with the posterior rhythm in younger subjects (see Figures 11-17 and 11-18). They are confined to the occipital areas and suppress with...
eye opening along with the posterior rhythm. Typically, these posterior slow waves briefly interrupt sustained runs of the posterior rhythm, sometimes making it difficult to count. Posterior slow waves of youth appear after age 7 years and are commonly seen up to the middle of the second decade. They become distinctly less common during the late teenage years and are only rarely seen after age 20, by which time posterior slow waves may be abnormal. Posterior slow waves of youth usually occur singly and do not exceed the amplitude of the posterior rhythm by more than 50%. Amplitude asymmetries are not uncommon with these waves and are not necessarily abnormal.

**K-complexes and Related “Evoked Responses”**

The k-complex is a normal element of sleep. K-complexes may occur either spontaneously or in response to an outside stimulus such as a noise in the environment. Occasionally, the bursting characteristic of a k-complex could be mistaken for a generalized spike-wave discharge because of embedded sharpened features. Occasional intermittent increases in voltage during drowsiness or sleep caused by an environmental stimulus may represent a type of evoked response; these may, indeed, represent brief arousal rhythms. Figure 11-19 shows the EEG response of a 33-year-old woman to a noise in the environment during drowsiness. The EEG technologist should note the relationship of such bursts to environmental stimuli, as appropriate, to aid in interpretation.

**Exaggerated Hyperventilation Response**

Hyperventilation responses are typically more dramatic in children compared with adults. The hyperventilation response is also easier to elicit when blood sugar is lower. In the absence of dramatic asymmetrical findings or clear epileptiform discharges, there is no defined upper limit of voltage for a “normal” hyperventilation response (see Figure 11-20) and hyperventilation hypersynchronies should not be considered abnormal based solely on voltage criteria at any age.

**Hypnogogic and Hypnopompic Hypersynchronies**

Hypnogogic (on falling asleep) and hypnopompic (on arousal) hypersynchronies are highly rhythmic, medium- or high-voltage waves seen diffusely across the EEG either on transition into sleep or on arousal. At times, these hypersynchronies can be dramatic and may potentially be mistaken for epileptiform activity or seizure activity (see Figure 11-21). Such hypersynchronies are usually easily distinguished from seizure activity on the basis of their occurrence at the time of sleep transitions and their monorhythmic nature: the frequency of these rhythmic waves holds steady throughout their course, which helps distinguish them from seizure activity.

**Photomyoclonic Response**

The photomyoclonic response is the result of a reactive twitching of the facial muscles to strobe stimulation (see Figure 11-22). This results in bursts of muscle
artifact occurring in tandem with the strobe flash. In some instances, the muscle potential bursts could be mistaken for spike-wave discharges. When the muscle spikes and eyeblink artifacts are visually removed, no other abnormalities are seen. The photomyoclonic response is not associated with seizures and is therefore considered a normal variant.

**Spiky Alpha**

The posterior rhythm is usually a sinusoidal rhythm, but a variant morphology, “spiky alpha,” may be seen in a minority of patients. Spiky alpha waves are rounded on one side and spiky on the other (see Figure 11-23), similar to the arciform pattern seen with mu and similar rhythms. Spiky alpha variant is usually easy to recognize as such; the danger comes in finding fragments of spiky alpha and mistaking them for occipital spikes.

**Slow Alpha Variant and Fast Alpha Variant**

The slow alpha variant is a variant of the posterior rhythm in which a subharmonic frequency of the posterior rhythm (half the frequency) is either superimposed on or replaces the posterior rhythm itself. Figure 11-24 shows a patient with a 9-Hz posterior rhythm. Later in the page, a prominent 4.5-Hz rhythm is seen. Replacement of the posterior rhythm with a subharmonic frequency is considered a normal variant and should not be considered a slow-wave abnormality. More rarely, the posterior rhythm may be replaced with a higher harmonic frequency, typically a doubling of the fundamental posterior rhythm. This phenomenon is referred to as fast alpha variant (see Figure 11-25).

**Cascading Vertex Waves**

Vertex waves during Stage II sleep typically appear in a periodically repetitive fashion, often in conjunction with a spindle. In some patients, highly repetitive or “cascading” vertex waves may be seen for periods of time without pauses (see Figure 11-26). Although their appearance may be dramatic, this pattern can be considered a normal variant of vertex wave expression.

**Spindle Fragments and Posterior Rhythm Fragments**

Sleep spindle rhythms typically appear in runs lasting from one to several seconds. Occasionally, a fragment of this normal waveform can appear, giving a misleading impression. Figure 11-27 shows two apparent sharp
Even in patients who do not have epilepsy, the hyperventilation response can be dramatic, as it is in this young patient. In the absence of definite epileptiform features, very high-voltage hyperventilation responses should not be considered abnormal.
Figure 11-21  This example of a hypnopompic hypersynchrony (hypersynchrony occurring on arousal) occurs out of Stage II sleep when the technologist awakens the patient. This particular pattern consists of a mixture of rhythmic, high-voltage 1-Hz delta with a lower voltage 6-Hz theta rhythm. The fact that these frequencies do not evolve helps to exclude a seizure discharge. Some of the high-voltage deflections seen in the C3 electrode are probably due to a poor electrode contact.
Repetitive muscle spikes are seen in the frontal areas during strobe stimulation. These artifactual spikes should not be mistaken for spike-wave discharges. The photomyoclonic response is seen more commonly in subjects with increased tension or anxiety. Visual observation of the patient shows that it is caused by rhythmic eye-twitching/blinkning in time with the strobe. The timing of the strobe flashes is shown by the vertical lines in the bottom channel. A normal photic driving response is well seen in the channels that include the O1 and O2 electrodes.

Figure 11-23  The posterior rhythm may become sharpened on one or both sides in some patients (arrows). This normal variant of the posterior rhythm is called spiky alpha variant.
Chapter 11  Normal Variants in the Electroencephalogram

Figure 11-24  This patient has a fundamental posterior rhythm of 10 Hz (black arrow). At times a prominent and higher voltage 5-Hz rhythm is seen in the same region (gray arrow), representing a subharmonic of the fundamental 10-Hz rhythm. In this example, both the 5-Hz and the 10-Hz rhythm (in the form of notching of the 5-Hz rhythm) can be seen at the same time. In other patients, a pure subharmonic of the fundamental rhythm can be seen without notching (e.g., a pure 5-Hz rhythm taking the place of the posterior rhythm). In such cases, the presence of slow alpha variant can be confirmed by finding the fundamental posterior rhythm frequency elsewhere in the record, which should be a higher multiple of the slower frequency.

Figure 11-25  (A) This patient’s fundamental posterior rhythm frequency is well seen. (B) A combination of the fundamental posterior rhythm and its first harmonic frequency (double the fundamental frequency) is seen in the form of a “notched” version of the posterior rhythm. (C) A pure version of the harmonic frequency, the “fast alpha variant.”
Although vertex waves usually occur in a repetitive, on-and-off pattern, less commonly they may be seen as relatively continuously appearing discharges. The maxima of these waves at Cz, C3, and C4 and the relative exclusion of the waves' field from the temporal areas help to identify them as vertex waves of sleep, despite their repetitive nature.

Two possible low-voltage spikes are noted in the left central region (arrows). The possibility that these represent low-voltage spikes can be excluded after it is recognized that they have the exact same morphology as the spindle wave seen at the beginning of the page (shaded area) and are examples of spindle fragments.
waves in the left central area. In fact, these are fragments of a sleep spindle, seen in a more typical form at the beginning of the page. Occasionally, fragments of the posterior rhythm may also appear singly, suggesting a single sharp wave (see Figure 11-28). When the morphology of the suspected wave fragment can be seen to match perfectly with previous, easily recognizable examples of the posterior rhythm, the benign nature of the wave can be confirmed. Similar phenomena involving wave fragments of mu rhythms and wicket rhythms are discussed earlier in the chapter.

**Figure 11-28** (A) An apparent sharp wave is seen in the left occipital area (arrow). (B) The same wave is now recognized in the context of the posterior rhythm (arrow), confirming that it is a posterior rhythm fragment rather than a sharp wave. The posterior rhythm fragment seen in Panel A was likely caused by rapid eye closure (note the eyeblink artifact in the frontal channels occurring at the same time as the wave fragment).
REFERENCES


