

# Auditory Brain-Stem Potentials With Unilateral Pontine Hemorrhage

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● Although there have been extensive anatomical and physiological studies in animals, the actual neural sources, or even the laterality, of some components of auditory brain-stem evoked potentials in humans are uncertain. We studied these responses in a 56-year-old patient who had a clearly demarcated pontine hemorrhage on the right side. The patient was somnolent, with dense left hemiplegia and signs of involvement of right cranial nerves V, VI, and VII. Stimulation of the left ear (ie, contralateral to the lesion) evoked a normal series of waves with clearly resolved positive components peaking at 2.0 ms (wave I), 3.3 ms (wave III), 4.8 ms (wave IV), and 6.0 ms (wave V). Stimulation of the right ear (ie, ipsilateral to the lesion) evoked only waves I, III, and IV. These results suggest that a pathway ipsilateral to the stimulated ear is necessary and sufficient for generation of auditory wave V and that wave IV is generated in bilateral pathways.

(*Arch Neurol* 1985;42:767-768)

Although there have been extensive anatomical and physiological studies in animals,<sup>1,2</sup> the actual neural sources, or even the laterality, of some components of auditory brain-stem evoked potentials in humans are

uncertain.<sup>3</sup> Although anatomical and physiological studies in animals indicate that components occurring after wave III are generated in the brain stem contralateral to the stimulus,<sup>1,2</sup> Chiappa et al<sup>3,5</sup> and others<sup>6</sup> have presented clinical-physiological correlations in a few patients that suggest a brain-stem source ipsilateral to the stimulated ear. We studied these potentials in a patient who had a unilateral pontine hemorrhage; the results in this study suggest an ipsilateral source for wave V and bilateral source for wave IV.

## PATIENT AND METHODS

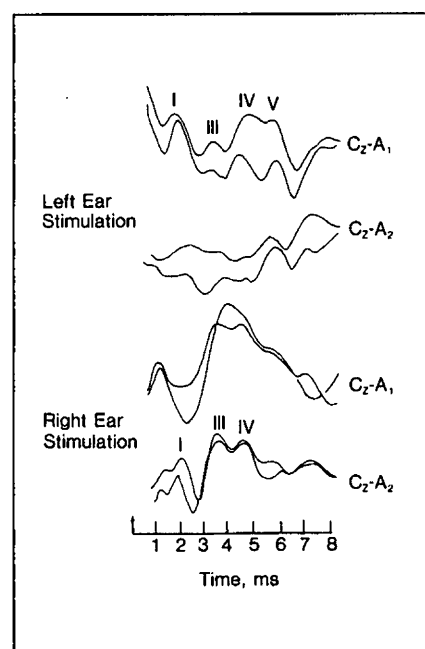
The patient was 56 years old, somnolent, but easily arousable. He could respond to commands, and was severely dysarthric. He had no lateral eye movements; there was intermittent ocular bobbing. He had a good down gaze, with coarse downbeat nystagmus. There was a marked right lower motor-neuron seventh nerve lesion. There was also left hemiparesis, with increased extensor tone on the left; plantar flexion and triple flexion responses were present on the left. Computed tomography showed a unilateral right-sided pontine lesion extending superiorly to the quadrigeminal plate cistern and fourth ventricle. Electroencephalography showed mild diffuse slowing. The unilaterality of the hemorrhage was confirmed at postmortem examination, which disclosed only a small extension across midline at the level of the trapezoid body (Fig 1).

Auditory brain-stem evoked potentials were recorded at bedside (amplifier band-pass: 80 to 1,600 Hz). Stimulus intensity was 85-dB hearing level. Potentials were recorded in response to independent stimulation of each ear. Rarefaction only a small extension across midline at the level of the trapezoid body (Fig 1).

## RESULTS

Evoked potential waveforms are shown in Fig 2. Stimulation of the left ear evoked a normal complex of waves with clearly resolved positive components peaking at 2.0 ms (wave I), 3.3 ms (wave III), 4.8 ms (wave IV), and 6.0 ms (wave V). Stimulation of the right ear evoked clearly resolved components at 2.1 ms (wave I), 3.75 ms (wave III), and 4.6 ms (wave IV). A wave V was not seen.

Fig 1.—Auditory brain-stem evoked potentials in response to independent stimulation of left and right ears. Two replications are shown. Stimulation of left ear evoked clear waves I, III, IV, and V; stimulation of right ear evoked waves I, III, and IV.



Accepted for publication July 3, 1984.  
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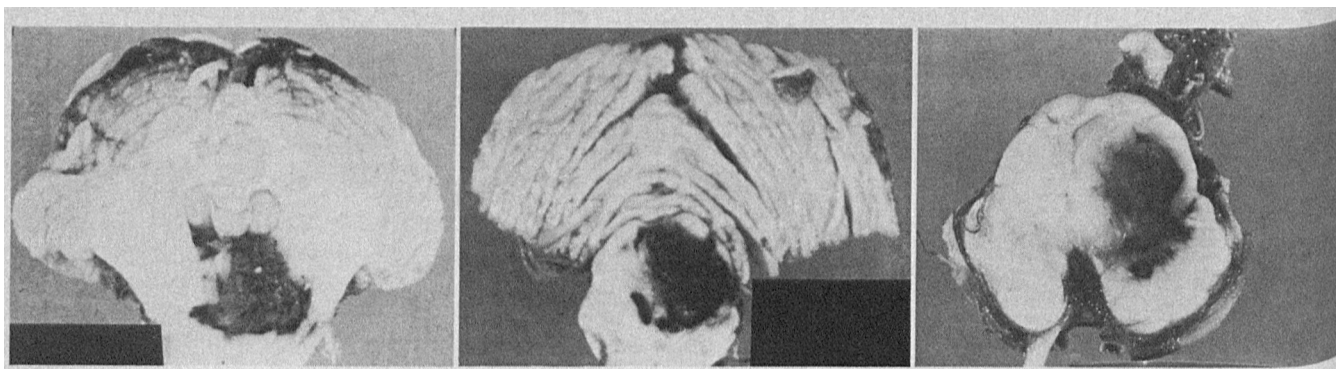


Fig 2.—Sections of brain taken one week after recordings shown in Fig 1. Left, Level of trigeminal nerve; center, level at midpons; right, level of midbrain just caudal to inferior colliculus. In left section, extension of lesion across midline is seen.

#### COMMENT

This patient had a sharply demarcated right-sided pontine hemorrhage, which extended from just above the pontomedullary junction up to the midbrain (Fig 2). A clear wave I is seen in response to stimulation of either ear. For right ear stimulation, wave II is clearly absent (a normal variant). Wave III is clearly present in response to right ear stimulation; for left ear stimulation, a smaller-amplitude wave (3.3 ms), which could represent wave II or a foreshortened wave III, is seen; this is possibly a reflection of extensive damage at the level of the trapezoid body. Stimulation of the right ear (ie, ipsilateral to the lesion)

failed to evoke a wave V, whereas stimulation of the left ear (contralateral to the lesion) evoked a clear wave V. This suggests a brain-stem source for wave V, which is ipsilateral to the stimulated ear. Wave IV was present in response to either left or right ear stimulation. These results are in agreement with clinical data presented by Chiappa et al.<sup>3-5</sup> Starr and Squires<sup>7</sup> presented topographical mapping studies in response to condensation click stimuli and arrived at similar conclusions concerning the generator(s) of wave IV. A 1983 study in animals<sup>8</sup> indicated an ipsilateral source for the P4 wave (analogous to the human wave V).

Although the auditory pathway is commonly thought to be predominantly crossed, there is an ample uncrossed pathway. The anteroventral cochlear nucleus projects to both the contralateral and ipsilateral ventral nuclei of the lateral lemniscus,<sup>9</sup> which in turn sends third-order fibers to the ipsilateral inferior colliculus.<sup>10</sup> In the primate there is also a pathway of second-order neurons from the cochlear nucleus to both ipsilateral and contralateral inferior colliculi.<sup>11</sup>

Alice Cullu and Anne Crawford of the Veterans Administration Research Service editorial office and Shirley Dunbar gave secretarial assistance.

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