

Neuronal Generators and the Problem of Localization in Electroencephalography: Application of Volume Conductor Theory to Electroencephalography

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The principal tasks of the clinical electroencephalographer are to recognize particular waveforms of diagnostic significance, such as, for instance, spikes, sharp waves, delta waves, and to identify the likely location of their generators within the brain. The first of these, which is one of pattern recognition, is relatively easy to learn, but the second is difficult and requires an adequate understanding of some basic principles of physics and electrophysiology. Potential differences, in the brain as elsewhere, reflect the segregation of electrical charges at certain locations within a three-dimensional body. Although, generally speaking, the potential measured at some distance from an electrical charge decays with increasing distance according to a parabolic function, the situation is not as simple as one might infer from this. Thus, it is not necessarily true that the potential (or the potential difference between two electrodes) generated by a neuronal source is greater, the closer the measuring electrodes are to this source. The lack of a simple relationship between the size of a potential measured at a given point and the distance of this point from the generator derives from the fact that the generators of the EEG are not simple point-like charge accumulations, but have dipolar configurations (Bishop, 1949; Brazier, 1949; Li et al., 1956*a,b*; Spencer and Brookhart, 1961*a,b*; Creutzfeldt and Houchin, 1974; Kostopoulos et al., 1982; Gloor, 1983). More importantly, they are not even simple dipoles, but dipole layers that are convoluted (Bishop, 1949; Gloor et al., 1963; Calvet et al., 1964; Fourment et al., 1965; Vaughan, 1969, 1974, 1982; Gloor, 1975; Ball et al., 1977*a,b*; Klee and Rall, 1977). Their particular geometry and orientation with regard to the exploring electrodes are crucial determinants of the potential distribution within or at the surface of the three-dimensional body containing the generator (Gloor et al., 1963; Calvet et al., 1964; Jami et al., 1968; Vaughan, 1969, 1974; Gloor, 1975; Klee and Rall, 1977). In the daily practice of reading EEGs, often little attention is paid to these factors, and superficial conclusions

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