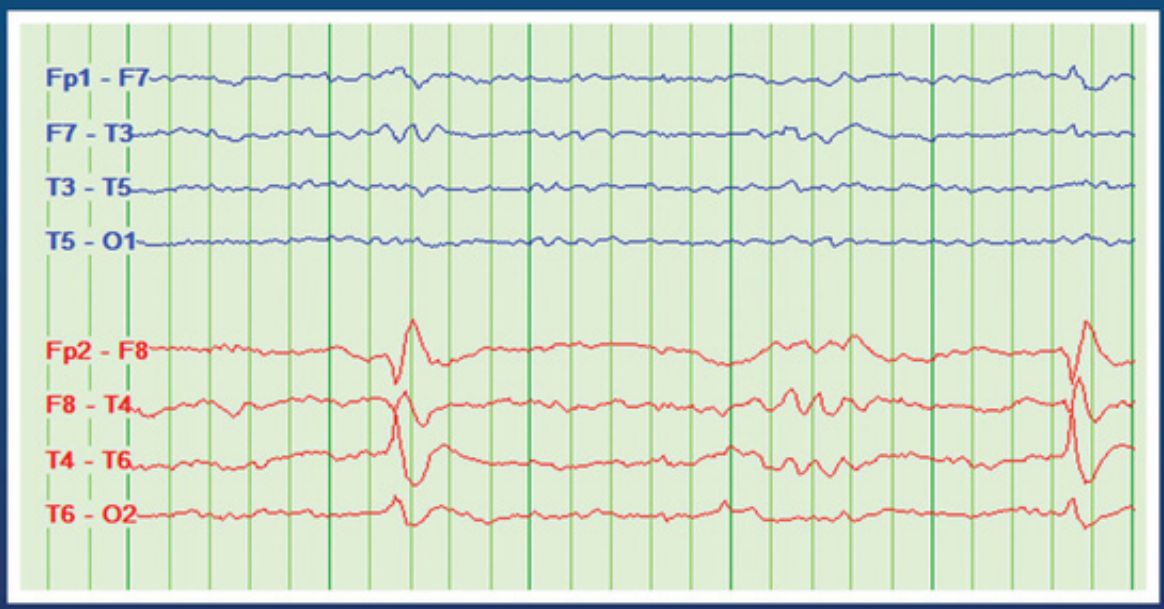
CLINICAL EEG

OF ADULTS AND ADOLESCENTS



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Clinical EEG of Adults and Adolescents

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This book is dedicated to Kerri Remmel, MD, PhD, Professor emiritus and former Chair of the Department of Neurology at the University of Louisville School of Medicine, and to Professors M. Steven Evans, MD, MS and Christopher Shafer, MD.

Brief Contents

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Chapter 1
Arrays and Montages

1.1 Arrays

As the field of electroencephalography developed, the need for a standardized array of electrodes became increasingly apparent, resulting, in 1958, in the adoption of the International 10–20 System. Subsequently, the need for more closely spaced electrodes to allow for more precise localization led to an expansion of this system into what has come to be known as the Modified Combinatorial 10–10 System.

One, very important, failing of the International 10–20 System has been its inability to capture epileptiform discharges arising from seizure foci in the medial and anterior aspects of the temporal lobe. Of the multiple attempts to remedy this failing, two have found their way into clinical practice: first, utilizing a portion of the 10–10 System, namely, the inferior temporal chain; and, second, using one of the supplemental noninvasive electrodes, namely, the "true" anterior temporal electrode. Both of these are discussed at the end of this chapter.

1.1.1 International 10–20 System

The International 10–20 System was first described by Jasper in 1958 (Jasper 1958) and has become a worldwide standard. In developing this system, Jasper decided that "[p]ositions of electrodes should be determined by measurement from standard landmarks on the skull. . ." and that these "[m]easurements should be proportional to skull size and shape, insofar as

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possible." The standard landmarks Jasper chose were the nasion, the inion, and the preauricular points, and to maintain proportionality to the individual skull size, Jasper, rather than using predetermined distances in centimeters, decided on using percentages of the distances between these points on the individual patient's head.

The first line to be drawn lies in the midline and extends from the nasion to the inion. The first point on this line, according to Jasper (1958), is the Fp midline point, and this point "is 10 per cent of the nasion-inion distance above the nasion; the second point (F) is 20 per cent of this distance back from the point Fp, and so on in 20% steps back for the Central, Parietal, and Occipital points (hence the name 10-20 system)."

The next line to be drawn is "based upon the Central coronal plane. The distance is first measured from the left to right preauricular points . . ." and Jasper (1958) cautions that we "[b]e sure the tape is passing through the predetermined Central point at the vertex when making this measurement. Ten per cent of this distance is then taken for the Temporal point up from the pre-auricular point on either side. The Central points are then marked 20 per cent of the distance above the temporal points. . ."

The next line to be drawn is an "A-P line of electrodes over the temporal lobe, frontal to occipital, (and this) is determined by measuring the distance between the Fp mid line point . . . through the T position of the Central line, and back to the mid-occipital point. The Fp electrode position is then marked 10 per cent of this distance from the mid-line in front, and the Occipital electrode position 10 per cent of the distance from the mid-line in back. The inferior Frontal and posterior Temporal positions then fall 20 per cent of the distance from the Fp and O electrodes, respectively along this line" (Jasper 1958).

"The remaining mid-Frontal (F3 and F4) and mid-Parietal (P3 and P4) electrodes are then placed along the Frontal and Parietal coronal lines respectively, equidistant between the mid-line and temporal line of electrodes on either side" (Jasper 1958).

In explaining the rationale for the names of the various electrodes, Jasper (1958) commented that "[t]raditional anatomical terms have been employed to designate electrode positions over the various lobes of the brain, with the exception of the Central region which is, strictly speaking, partly frontal and partly parietal."

He goes on to note that "[i]n order to differentiate between homologous portions over left and right hemispheres it was decided to use even numbers as subscripts for the right hemisphere, and odd numbers for the left hemisphere . . . Electrodes at the mid-line in Frontal, Central and Parietal regions were originally designated F_0, C_0 and P_0 but this led to some confusion since P_0,

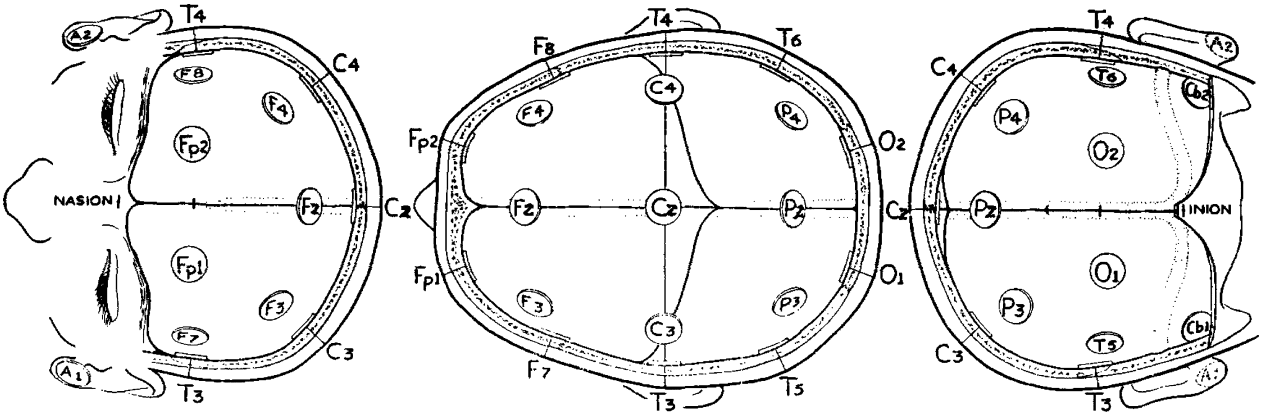

Figure 1.1 The complete International 10–20 System.
SOURCE: Jasper (1958)/with permission of Elsevier.

for example, might be interpreted as parieto-occipital. Consequently the midline positions have been changed to F_z, C_z and P_z ($_z$ for zero!)." The complete system of placements is shown in Figure 1.1 and schematically in Figure 1.2.

The full names of each of Jasper's 21 alphanumeric designations are given in Table 1.1. Subsequently, however, two alternative names have gained currency. The first alternative is trivial: "auricle" has been replaced by "ear." The second, however, is far more significant. In the same year that Jasper published his study, Abraham and Ajmone Marsan (1958) referred to F7 and F8 not as "inferior frontal," but as "anterior temporal," and this designation has stuck, despite the fact, as discussed below, that F7 and F8 do not overly the temporal lobe at all.

1.1.2 Anatomical Position of Electrodes of the International 10–20 System

Jasper (1958) stated that "[a]natomical studies should be carried out to determine the cortical areas most likely to be found beneath each of the standard electrode positions," and in his paper he briefly described two such studies.

"Two methods were employed: (1) metal clips placed along the Central and Sylvian fissures at operation were then used to identify these fissures in X-ray studies of the skull after the EEG electrodes had been applied, and (2) electrode positions were carefully marked on the heads of cadavers, drill holes placed through the skull, and the cortex marked with India ink in each position before removing the brain for examination. Brains with gross lesions or focal atrophy were excluded."

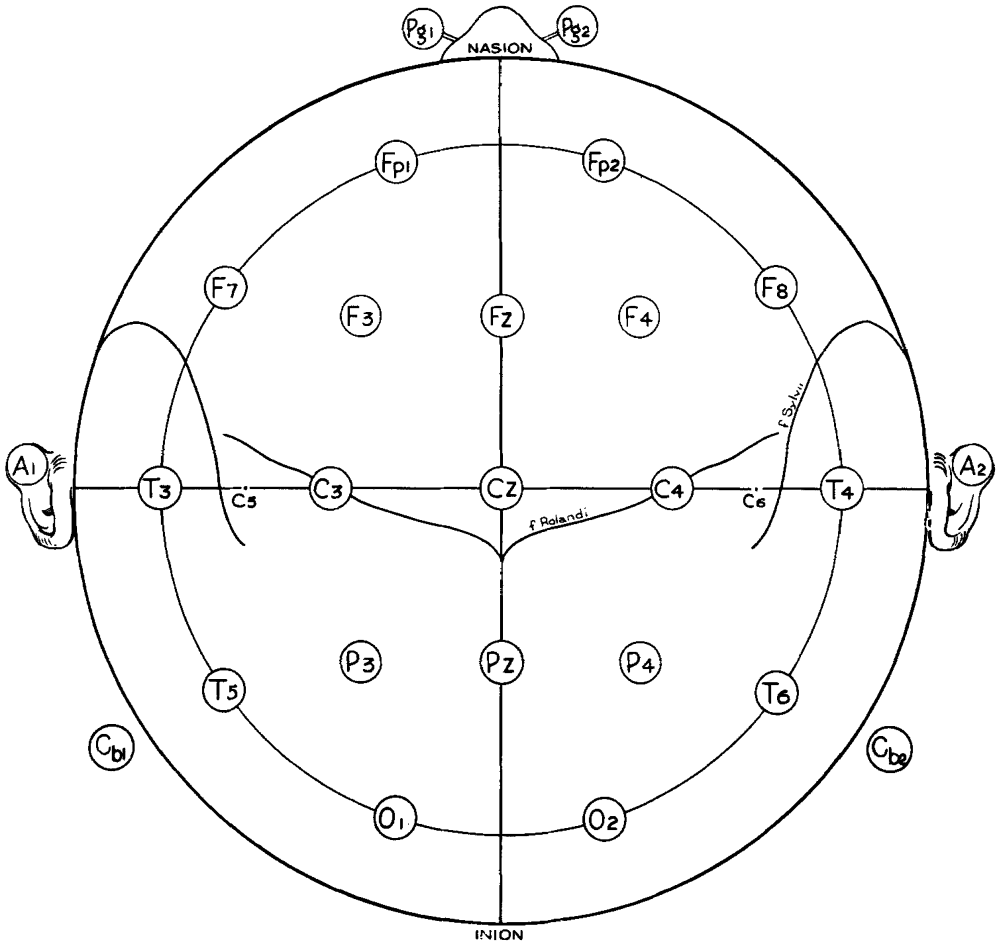

Figure 1.2 The complete International 10–20 System in schematic form.
SOURCE: Jasper (1958)/with permission of Elsevier.

Table 1.1 Electrode names in the International 10–20 System

		Fp1 left frontopolar		Fp2 right frontopolar		
	F7 Left inferior frontal[a]	F3 Left frontal	F_z Frontal midline	F4 Right frontal	F8 Right inferior frontal[a]	
A1 Left auricle	T3 Left mid-temporal	C3 Left central	C_z Central midline	C4 Right central	T4 Right mid-temporal	A2 Right auricle
	T5 Left posterior temporal	P3 Left parietal	P_z Parietal midline	P4 Right parietal	T6 Right posterior temporal	
		O1 Left occipital		O2 Right occipital		

[a] F7 and F8 are also known as "anterior temporal" electrodes.