Chapter 1.1

The ten–twenty electrode system of the International Federation

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During the First International EEG Congress, London in 1947, it was recommended that Dr. Herbert H. Jasper study methods to standardize the placement of electrodes used in EEG (Jasper 1958). A report with recommendations was to be presented to the Second International Congress in Paris in 1949. The electrode placement systems in use at various centers were found to be similar, with only minor differences, although their designations, letters and numbers were entirely different.

Dr. Jasper established some guidelines which would be established in recommending a specific system to the federation and these are listed below.

1. The position of electrodes placed should be based on specific measurements of standard skull landmarks. The measurements should be proportional to the size and shape of the skull.
2. Adequate coverage of all parts of the head should be provided with standard electrode placement.
3. Electrode designations would be expressed in terms of brain areas covered rather than only in numbers. This would make communications more meaningful to the non-specialist, as well as workers in other laboratories.

4. Finally, anatomical studies would be carried out which would provide additional documentation correlating the electrode placement with the cortical areas which they record from.

Technique of measurement

The measurement technique is based on standard landmarks of the skull. Namely, the nasion, inion, and the left and right preauricular points. The preauricular points are felt as depressions at the root of the zygoma, just anterior to the tragus.

The first measurement is in the anterior-posterior plane through the vertex, taken from the nasion to the inion. This measurement is divided into 5 separate areas (see Fig. 1). The first mark is placed at 10% of the total measurement and labeled Fp. The second, third, fourth and fifth marks are placed at 20% intervals of the total measurement and labeled F, C, P, and O. Note that the O mark would be located at 10% of the measurement above the inion. The expression Fp, F, C, P and O represent the fronto polar, frontal, central, parietal and occipital areas, respectively.

Lateral measurement of the central coronal plane starts at the left preauricular point through the C vertex mark to the right preauricular point (Fig. 2). A mark is placed at 10% of this measurement over the preauricular points and labeled T. The

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expression T represents the temporal area. Marks are then located at 20% of the lateral measurement and labeled left and right C, and the C vertex location is crossed.

A circumferential measurement (Fig. 3) is then taken over the temporal lobes from the midline Fp position to the midline O position. A mark is made at 10% of this measurement indicating the left or right Fp electrode position. Marks are then made at 20% of the measurement and are labeled inferior frontal, mid-temporal, and posterior temporal and left or right occipital (note that the mid-temporal electrode positions are crossed). The remaining 10% measurement from the left and right occipital marks would be the midline O position. Variations of this measurement have been described by Harner and Sannit (1974).

Antero-posterior measurements are taken from the left and right Fp position through the lateral C position to the left and right O position. This measurement is then divided equally by 25% marks and labeled lateral F, lateral C, and lateral P. Anterior coronal measurements are taken from the left and right inferior frontal position through the midline F position and divided into 25% segments, making crosses at the left lateral frontal, F vertex and right lateral frontal positions. A posterior coronal measurement is taken from the left posterior temporal mark through the midline...
P position and this is also divided into 25% segments and marks are labeled left lateral P, midline P and right lateral P (Fig. 4).

These measurements provided for the location of 19 of the 21 electrodes used in the 10-20 electrode system (Fig. 5). The remaining two electrodes were placed on the ear lobes and labeled auricular electrodes. The electrode positions were named in anatomical terms for the cortical areas recorded, with the exception of the ‘‘C’’ electrodes which were termed central since they were located over the central sulcus. A numbering system was added to differentiate between left and right homologous regions, odd numbers for the left hemisphere, Fp1, F3, F7, C3, T3, P3, T5, and O1. Even numbers for the right hemisphere, Fp2, F4, F8, C4, T4, P4, T6, and O2. The original recommendation called the F, C, and P vertex electrodes F0, C0, and P0, but later changed to Fz, Cz, and Pz (z for zero). The numbers selected allowed for additional electrodes to be placed in the coronal plane and have suitable designations (e.g. F2 placed between Fz and F4, and F6

Fig. 4. The lateral view of left and right hemispheres showing all standard electrode positions, omitting intermediate positions (such as C5 and C6) which are used only for special studies with more closely spaced electrodes. These drawings were made from a series of X-ray projections with true lateral views. The location of principal fissures was determined by silver clips placed at operation and by other anatomical studies described in the text. The location of pharyngeal electrodes (Pg1 and Pg2) was also obtained from X-ray studies with these electrodes in place.

Fig. 5. Frontal superior and posterior views showing all the standard electrode positions as described in the text.
placed between F4 and F8). Other additional electrodes included pharyngeal and cerebellar electrodes which were termed Pg1, Pg2, Cb1 and Cb2, respectively.

Anatomical studies

Anatomical studies were performed on the heads of cadavers to determine the cortical areas covered by each electrode position. Measurements were taken and the 10–20 system marked on the skulls, and electrodes were applied. Drill holes were placed through the skull and the underlying cortex was marked with India ink before removing the brain for examination. It was concluded that while there was some variability, the two principle fissures, central and sylvian, were within ± 1 cm of the marks shown on Fig. 6.

Comments

The 10–20 electrode system was adopted for trial and the meetings of the General Assembly of the International Federation in Paris in 1949. A variety of systems have been employed by others to include additional electrodes in the A–P plane. Recently the American Electroencephalographic Society (American Electroencephalographic Society 1999a,b) proposed and adopted Guideline 13: guidelines for standard electrode position nomenclature. This provided terminology for the use of additional electrodes placed in the sagittal plane. The location of these electrodes is shown in Fig. 7. Electrode nomenclature is also described in the latest IFCN standards (Nuwer et al. 1998).

References