

EEG ELECTRODE PLACEMENT

and

RECORDING TECHNIQUE

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THE TEN TWENTY ELECTRODE SYSTEM OF THE INTERNATIONAL FEDERATION

INTERNATIONAL COMMITTEE OF PROCEDURES

I. PRINCIPLES

A. GENERAL:

1. Position of electrodes determined by measurement from standard landmarks on skull. Measurements should be proportional to skull size and shape.
2. Adequate coverage of all parts of head by standard designated positions.
3. Designation of positions in terms of brain areas (frontal, parietal, etc.), not only in numbers-- so communication would be more meaningful to non-specialist.
4. Anatomical studies to determine cortical area beneath each electrode in average subject.

II. METHOD OF MEASUREMENT

A. AP MEASUREMENT:

1. Midline--based on distance between nasion and inion, over vertex, in midline.

2. 5 points marked along the line--Figure 1.

Fp - frontal pole - 10% distance from nasion.  
 F - frontal - 20% from Fp.  
 C - central - 20% from F.  
 P - parietal - 20% from C.  
 O - occipital - 20% from P - 10% from inion.

Central line is half distance from nasion to inion.

B. LATERAL MEASUREMENTS:

1. Based on central coronal plane.
2. 1st measurement:
  - a. Left to Right preauricular points (depression at root of zygoma anterior to tragus--tape to pass through predetermined central point (at vertex).
  - b. Temporal points - 10% of distance up from preauricular points.
  - c. Central points - 20% of distance above temporal point Fig.2.

TEN TWENTY INTERNATIONAL ELECTRODE SYSTEM, cont'd

3. AP Line - frontal to occipital over temporal lobes. Fig. 3.

a. Distance between Fp (midline) through T position of central line and back to mid-occipital point (O).

b. Fp electrode position--10% distance from midline in front.

c. O electrode position - 10% distance from midline in back.

d. Inferior frontal electrode - F7 - 20% distance from Fp.

e. Posterior temporal electrode - T5 - 20% distance from O.

C. MID-FRONTAL (F3 and F4) and MID-PARIETAL (P3 and P4) - placed along frontal and parietal coronal lines respectively, equivalent distance between the midline and temporal line. Fig. 4.

D. NUMBER OF ELECTRODES:

1. Total - 21

2. Includes midline in frontal central and parietal regions.

3. 2 auricular electrodes.

4. Separation same for all pairs in AP measurement.

5. Coronal lines equally spaced - slightly shorter distance between auricular and mid-temporal points.

6. Additional electrodes may be placed between any of the standard positions - numbers provided.

III. DESIGNATION OF ELECTRODE POSITIONS

A. ACCORDING TO ANATOMICAL TERMS - except central lead which is central lobe, posterior frontal and posterior parietal (central sulcus) (sensory-motor area).

B. HOMOLOGOUS DESIGNATION

1. Even number subscripts for RIGHT (F4, etc.)

2. Odd " " " LEFT (F3, etc.)

3. Numbers selected to allow for other numbers to be used - for special studies.

4. Midline positions designated as Z, as Fs, etc.

5. Complete system of designations in Figs. 4, 5, 6.

TEN TWENTY INTERNATIONAL ELECTRODE SYSTEM, Cont'dC. EXTRA POSITIONS

1. Pg1 & Pg2 - Pharyngeal.
2. Cb1 & Cb2 - (Cerebellar) Posterior Fossa.

IV. ANATOMICAL STUDIES

A. Metal clips placed along central and Sylvian fissures. X-ray of skull with electrodes applied - located according to clips.

B. Electrodes marked on cadavers, drill holes in skull, cortex marked with ink in each position before removing brain for examination.

C. Position of the two fissures is within plus or minus 1 cm. of that indicated in drawings - with carefully made measurements.

D. Central fissure - oblique - upper C electrode lies in pre-central and lower in post-central area.

V. FIGURE 6 - to be used to make stamp.

JASPER, HERBERT H., M.D.: THE TEN TWENTY ELECTRODE SYSTEM OF THE INTERNATIONAL FEDERATION (Appendix to Report of the Committee on Methods of Clinical Examination in Electroencephalography). EEG Clin. Neurophysiol., 1958, 10: 371.

TEN TWENTY INTERNATIONAL ELECTRODE SYSTEM, Cont'd

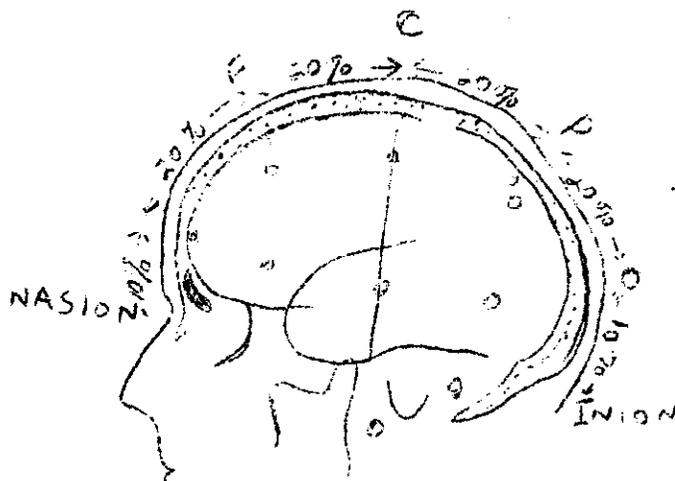


Fig. 1

Lateral view of skull to show methods of measurement from nasion to inion at the mid-line. Fp is frontal pole position. F is the frontal line of electrodes, C is the central line of electrodes, P is the parietal line of electrodes, and O is the occipital line. Percentages indicated represent proportions of the measured distance from the nasion to the inion. Note that the central line is 50% of this distance. The frontal pole and occipital electrodes are 10% from the nasion and inion respectively. Twice this distance, or 20%, separates the other line of electrodes.

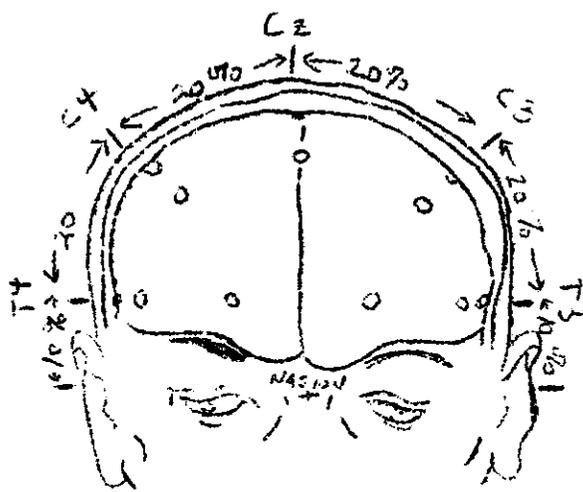


Fig. 2

Frontal view of the skull showing the method of measurement for the central line of electrodes as described in the text.

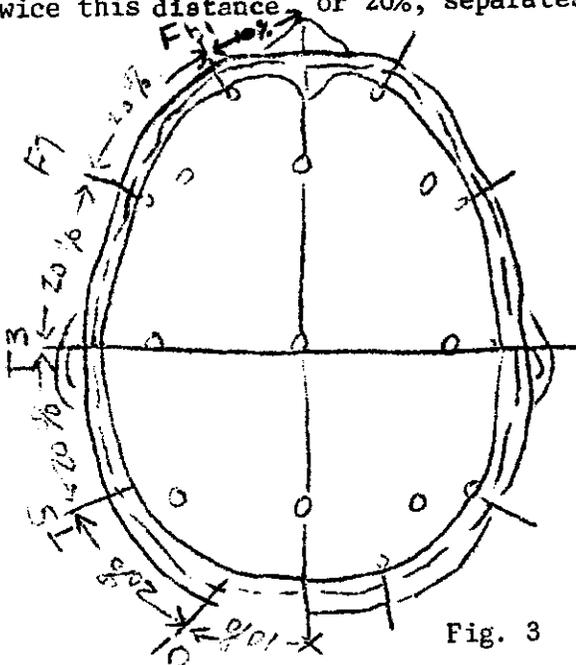


Fig. 3

Superior view with cross section of skull through the temporal line of electrodes illustrating the 10/20 system applied in this direction as described in the text.

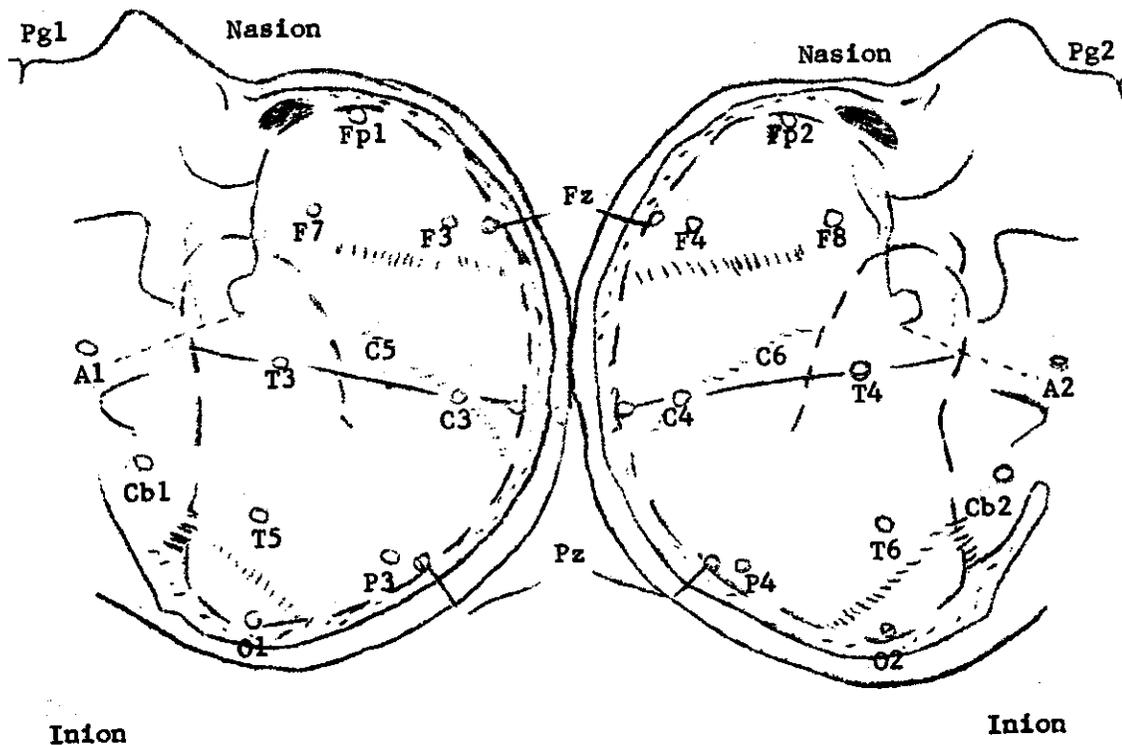
TEN TWENTY INTERNATIONAL ELECTRODE SYSTEM, cont'd

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 (Pg 1 and Pg 2) was also obtained from X-ray studies with these electrodes in place.

## TEN TWENTY INTERNATIONAL ELECTRODE SYSTEM, cont'd

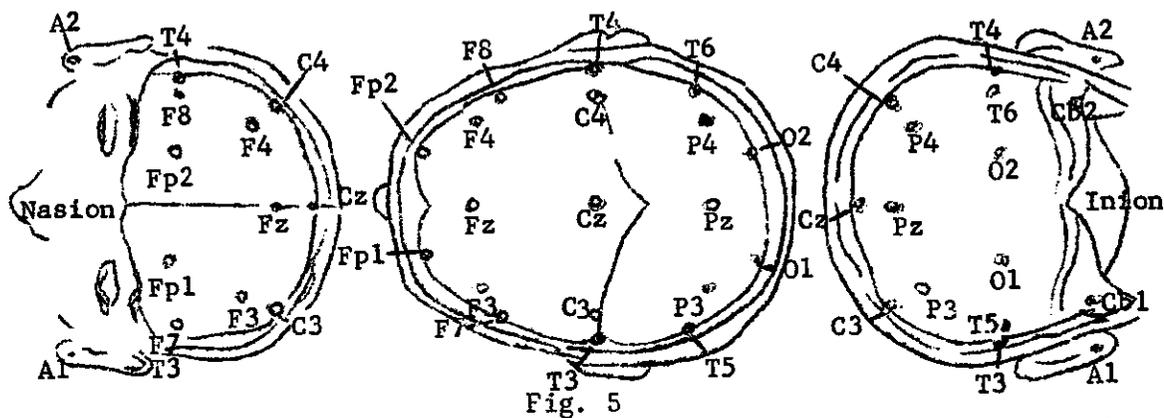


Fig. 5  
Frontal superior and posterior views showing all the standard electrode positions.

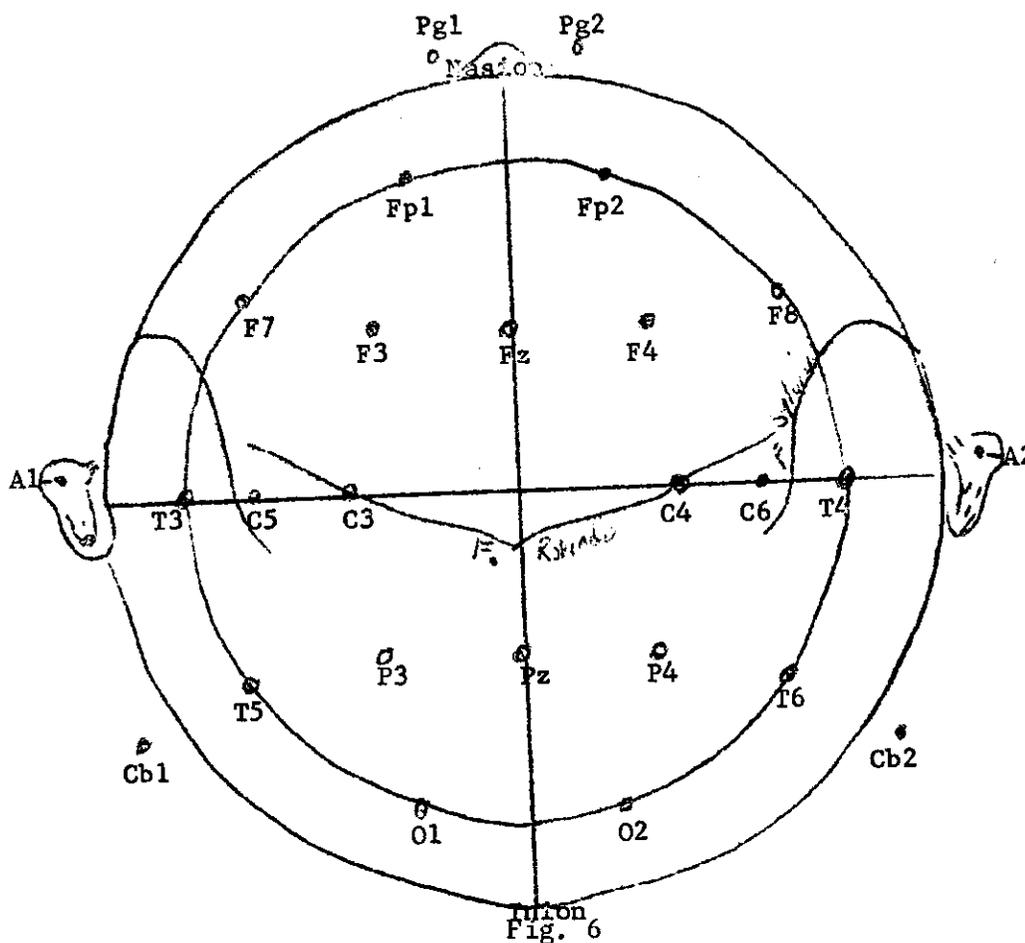


Fig. 6  
A single plane projection of the head, showing all standard positions and the location of the Rolandic and Sylvian fissures. The outer circle was drawn at the level of the nasion and inion. The inner circle represents the temporal line of electrodes. This diagram provides a useful stamp for the indication of electrode placements in routine recording.

RECORDING TECHNIQUESECTION I: 18 LEAD TECHNIQUE FOR RECORDING BRAIN WAVES ON ADULTS

(See Section II for Recording on Small Children)

A. CALIBRATION--to be done at beginning and end of recording.

1. Calibrate: Mechanically ... 10 seconds (7 mm. pen deflection at 50uV. This may be increased or decreased in cases of unusually high or low amplitude records. In such instances all variations in gain should be calibrated).
2. Calibrate: C3-01 ..... 10 seconds (NG on Grass)

B. BIPOLAR RECORDING

1. Fp1-F3, Fp2-F4, F3-C3, F4-C4, C3-P3, C4-P4, P3-01, P4-02 ..... 3-5 min.
2. Fp1-F7, Fp2-F8, F7-T3, F8-T4, T3-T5, T4-T6, T5-01, T6-02 ..... 3-5 min.

C. MONOPOLAR RECORDING

1. Fp1-A1, Fp2-A2, F3-A1, F4-A2, C3-A1, C4-A2, P3-A1, P4-A2 ..... 3-5 min.

During this run keep patient awake (if possible).

2. F7-Cz, F8-Cz, T3-Cz, T4-Cz, T5-Cz, T6-Cz, O1-Cz, O2-Cz ..... 3-5 min.\*

During this run keep patient awake first 3-5 minutes. Since this is a temporal run, allowing the patient to go to sleep will precipitate both anterior temporal spiking of temporal lobe seizures, and the more posteriorly located 6&14/sec. positive spikes. \*At termination of this time, instruct patient to try to sleep, and if patient sleeps record for another 5-10 minutes. If not, the 3-5 minute period is adequate. At the end of this sleep period, awaken patient without turning off machine and continue for another minute.

If greater localization of 6&14/sec. positive spikes is desired, the special techniques below may be called upon.

D. HYPERVENTILATION

1. Fp1-A1, Fp2-A2, C3-A1, C4-A2, T3-A1, T4-A2, O1-A1, O2-A2:
  - a. Pre-HV ..... 1 min.
  - b. HV ..... 3 min.
  - c. Post-HV ..... 2 min.

E. CHANNEL REVERSAL: For any of the standard and special runs, whenever amplitude differences between homologous regions of the hemispheres are evident, the two or more channels which show these differences should be reversed and run for a period of a minute in order to rule out channel artifact. If calibrations are equal and no significant asymmetries are evident, a reversal is not required.

RECORDING TECHNIQUE, cont'dSection II: RECORDING ON SMALL CHILDREN, especially those with poor cooperation:

10 Lead Technique.

Calibration as in Section I.

In this recording disk electrodes are recommended.

A. BIPOLAR RECORDING

1. Fp1-C3, Fp2-C4, C3-O1, C4-O2, Fp1-T3, Fp2-T4, T3-O1, T4-O2 ..... 3-5 min.

B. MONOPOLAR RECORDING

1. Fp1-A1, Fp2-A2, C3-A1, C4-A2, T3-A1, T4-A2, O1-A1, O2-A2 ..... 3-5 min.
2. Fp1-Cz, Fp2-Cz, C3-Cz, C4-Cz, T3-Cz, T4-Cz, O1-Cz, O2-Cz ..... 3-5 min.

C. HV

1. Fp1-A1, Fp2-A2, C3-A1, C4-A2, T3-A1, T4-A2, O1-A1, O2-A2:
  - a. Pre-HV ..... 1 min.
  - b. HV ..... 3 min.
  - c. Post-HV ..... 2 min.

SECTION III: EXTRA RUNSA. ALTERNATIVES

On the Grass EEG some may prefer to interconnect the ear electrodes A1 and A2. This is simply carried out by switching the electrode selector to 9 & 10 NG on the Grass machine. In most instances this adds little information and may actually introduce cancellations and distortions. Other makes of EEG's deal with interconnections of ear electrodes differently. Such information may be obtained from the Company Instruction Manual.

In order to maintain a uniform, minimum standard, effective technique, it is recommended that all combinations other than those listed above should be considered as extra runs, to be performed when it appears that such other runs will be valuable in further clarifying an obscure finding.

B. ADDITIONAL RUNS

1. For better exploration of the tip of the temporal lobes, utilize recording 2, of Section I-C, but for F7 and F8 substitute T1 and T2 (not shown on the chart) which are located just above the zygoma, half-way between the outer canthus of the eye and the pre-auricular point.
2. Two combinations for searching for 6&14/sec. positive spikes are as follows:
  - a. Fp1-F7, F7-O1, O1-O2, O2-F8, F7-Fp2, T5-A2, T6-A1, EKG
  - b. Fp1-T5, T5-T6, T6-Fp2, T5-A2, T6-A1, C3-A1, C4-A2, EKG

RECORDING TECHNIQUES, cont'd

3. Combined bipolar and monopolar, as a check for questionable foci or suspected inter-electrode cancellations:

a. Fp1-F7, Fp2-F8, F7-T5, F8-T6

b. Fp1, Fp2, F7, F8 to A1 or A2, with the Grass electrode selector on 9 & 10 NG or 9 & 10 Gr. (optional).  
Other EEG's arranged according to their own method.

C. Unlimited combinations are available, including sphenoidal, tympanic, and cerebellar leads, but most information is obtainable by the procedure as outlined in Section I. All other combinations are refinements, subject to individual needs.

It is recommended that the basic standard recording consist of Section I, so that good inter-hospital comparison may be made and properly tabulated for statistical purposes.

SECTION IV: EEG REPORT

A. When a record is read, it is recommended that the report be divided into the following:

1. TEXT: This is the description of the EEG trace.
2. EEG DIAGNOSIS: This summarizes in a phrase or sentence the main feature or features of the record. Example: "Slow wave focus, left frontal, moderate".
3. CLASSIFICATION: Employed if letter classifications are used for statistics, as in many hospitals. If punch cards are used, this is unnecessary because the material will be classified on the punch card.
4. COMMENT or CONCLUSION: This is the electroencephalographer's opinion of the meaning of the record, clinical interpretation, correlation, etc. Because some doctors want an opinion and some do not, it is desirable for the electroencephalographer to separate his opinion from the purely descriptive features of the write-up.