VENTRICULAR ELECTROENCEPHALOGRAPHY*  
A DESCRIPTION OF THE TECHNIQUE  
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The clinical usefulness of electroencephalography is limited by the fact that scalp electrodes for physical reasons record only the activity of the superficial and subjacent tissue of the lateral and superior surfaces of the cerebral hemispheres. With present methods deep subcortical pathology cannot be detected or localized† nor can the origin of abnormal waves, such as the petit mal and psychomotor-like waves seen in epilepsy, be determined. In order to extend the clinical usefulness of electroencephalography, electrodes must be placed in or near deep subcortical structures. This has been attempted by means of a nasopharyngeal lead,¹ a procedure which is held by Jasper to be useful in the localization of lesions in the region of the third ventricle (p. 390 ff.²). Penfield (p. 426 ff.³), and Sachs, Schwartz and Kerr⁴ have made isolated observations on the electrical activity of deep structures at operation,‡ and the subcortical electrical activity of animals has been widely reported. The main practical objections to the routine use of deeply placed electrodes in humans are uncertainty as to the exact location of the electrodes, and fear of damaging subcortical structures. It was thought that both these objections could be obviated by the use of electrodes placed in the lateral ventricles. Since the ventricular fluid contains electrolytes and therefore transmits electrical impulses, ventricular electrodes should record the activity of the surrounding tissue. At the same time the procedure should carry no greater risk for the patient than a ventricular tap. We are presenting our method of ventricular electroencephalography with the hope that it can be applied profitably to the study of clinical problems by investigators to whom clinical material is available.

METHOD

Electrodes consist of a 6-inch length of lacquer-insulated copper wire. The insulation is scraped off the extreme tip of the end to be inserted in the ventricle, and off approximately ½ inch of the opposite end. The wire is marked off at suitable intervals from the recording tip with white gloss-enamel paint. Before the ventricular needle is inserted, the wire is carefully measured against it so that the wire can be inserted to the same depth as the needle. When a

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† With respect to recording by scalp leads, buried cortex such as that of the insula, or deep cortex such as that of the orbital surface of the frontal lobes or the sphenoidal surface of the temporal lobes presents the same problem as deep subcortical tissue.
‡ While this paper was in press, Walter and Dovey in Lancet (Jan. 5, 1946, 250: 5–9), described in detail the successful use of needle electrodes in delimiting subcortical tumors at operation, "direct electrogaphy."
20-gauge needle is used, No. 30 wire is most convenient. No. 28 wire is suitable for use with a larger needle. After the electrodes have been prepared, they are straightened carefully. Slight twists in the wire make insertion through the needle difficult. The wires are placed in a long glass tube which is stoppered with cotton or gauze, and sterilized by autoclaving. We have always discarded such electrodes after one use.

To insert the wires, a ventricular tap is made with a dull 20-gauge needle and syringe in the usual way, using as criteria of placement the sudden cessation of resistance to injection of air and the ability to withdraw cerebrospinal fluid. In monkeys, as in infants, it is easiest to tap the anterior horn of the lateral ventricle, and most of our recordings have been made with the electrodes in this position. In a few instances, electrodes have been placed in the posterior horns. Whenever possible electrodes are placed symmetrically in both ventricles. When the ventricular needle is in place, the wire is inserted to the proper depth as determined previously by measuring the wire against the needle. The wire is then held steady against a ruler resting on the head and the needle withdrawn over the wire. The wire is held firmly in place with collodion and cotton. The portion of the protruding wire from which the insulation has been removed is wound around a similarly treated length of wire, the other end of which is soldered to a plug-in. These scraped, attached ends are fixed firmly to each other and to a stationary object either with collodion and cotton or with adhesive tape. The wire plug-in is inserted into the plug-in box of a Grass amplifier in the usual manner.

Fig. 1 shows the electrodes marked and prepared for use, with the needle and glass holder. Scalp electrodes are used as well. Since the animals are unanesthetized, they are blindfolded at the time of the recording. Ether anesthesia is used for the ventricular tap, and then several hours are allowed to elapse before the recording is taken. Fig. 2 shows the ventriculogram of a monkey with the wires in place. It will be noted that the wire on the left has slipped out of the ventricle and is lying in brain substance. This happens frequently in monkeys and is apparently due to accidental dislodging of the wire while the needle is being withdrawn over it. For this reason it would probably be preferable to take recordings in humans with the ventricular wire lying undisturbed in the needle. This can be done if the needle is first insulated. As insulating material, we have used cellulose acetate. A needle is dipped into cellulose acetate solution, withdrawn very slowly, and allowed to dry in air. It may then be sterilized in alcohol or by autoclaving.

We have taken a few recordings in anesthetized monkeys with the ventricular wire lying in the insulated needle. An additional advantage of this method of recording is that the needle and the inserted wire may be used as a concentric needle electrode. For this purpose, a small scratch is made in the insulation of the needle close to the bevel, and a wire is attached to
the collar of the needle. A bipolar recording can then be made between the ventricular wire and needle.

Records have been made with a Grass electroencephalograph of ventricular to ground (ear) activity and of ventricular to ventricular activity, and have been compared with simultaneous monopolar recordings of frontal, parietal and occipital cortical regions.

![Fig. 2. Ventriculograms showing buried wire electrodes in place. Notice the bilateral, parasagittal bony defect, affording access to the whole length of the lateral ventricles.](image)

**RESULTS**

Recordings of ventricular electrical activity have been made in three humans* and thirty times in monkeys. Several tentative conclusions may be drawn. The method is safe. No symptoms have been noted while the wires were in place. Several monkeys died of tuberculosis, and postmortem examination of the brain revealed no lesions. The wires have been left in place in the monkeys for six hours without apparent symptoms.

Electrical activity as recorded by ventricular leads usually parallels cortical activity. Under certain conditions, however, recordings of ventricle to ear and of ventricle to ventricle are entirely different from cortical activity (Fig. 3). From this fact we assume that the ventricular leads record the electrical activity of the surrounding subcortical structures and not of the overlying cortex. This assumption is strengthened by the observation that simultaneous tracings from different portions of the ventricle may be completely dissimilar (Fig. 3A). Finally, ventricular leads are of value in lateralizing subcortical lesions. In several monkeys, focal irritative lesions

* These patients were obtained with the cooperation of Dr. Joseph L. Dorsey.
of various portions of the basal ganglia have produced abnormalities in only one of a pair of symmetrically placed ventricular leads (Fig. 3B).

**SUMMARY**

A technique is described for recording the electrical activity of the brain by means of wire electrodes inserted in the ventricles. After one and one-half years of experience with monkey recordings, we believe the method to be simple, safe, and adaptable to routine use in conjunction with ventriculography. By application of this method to man, it may be possible to lateralize deep subcortical lesions and to demonstrate the subcortical origin of various abnormal waves.

**REFERENCES**