EEG CHANGES FOLLOWING TOTAL CEREBRAL ANGIOGRAPHY IN PATIENTS WITH ORGANIC BRAIN LESIONS

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During total cerebral angiography on 30 patients with organic brain disease, two brain responses were detected, involving EEG desynchronization: a transient response (10-20 sec) arising at the time when the catheter was introduced into the aorta, and a more prolonged response (up to 20 min) to injection of the contrast material into the vascular system of the brain. Both responses occurred during angiography performed under local anesthesia or under superficial general anesthesia and both were blocked under deeper general anesthesia with the addition of the ganglion-blocking drug arfonad.

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Effects of injection of contrast materials into the vascular system of the brain during regional angiography and angiocardiography on the EEG have been reported in the literature [4, 6, 8-11]. No reports of investigations of the EEG during total cerebral angiography could be found.

The object of the present investigation was to study EEG changes following total cerebral angiography in patients with various organic brain lesions.

EXPERIMENTAL METHOD

Changes in the EEG following total cerebral angiography were investigated in 30 patients with brain lesions (15 with tumors, 10 with vascular disturbances, and 5 with inflammatory changes in the brain and meninges) 24 h before and 1, 3, and 5 days after angiography. The EEG of 16 patients was also recroded during total cerebral angiography.

Total cerebral angiography was performed in cases when the character and localization of the pathological process could not be established by other clinical methods.

The EEG before and after angiography was recorded under normal laboratory conditions on an "Alvar" electroencephalograph in accordance with the internationally adopted scheme, and during angiography in the operating room on an 8-channel "Alvar" electroencephalograph or "Mingograph-81" polygraph. When the EEG was recorded during angiography difficulties arose because ordinary silver or tin electrodes give shadows on the roentgenograms, interfering with analysis of the angiograms [6-8]. Special electrodes, permeable to x-rays, composed of aluminum amalgam [1] were used. A strip of amalgam 1 cm wide and 35-40 cm long was insulated with adhesive plaster throughout its length except at its end for an area of 1 cm^2, which acted as recording electrode. The EEG recorded by means of these electrodes is indistinguishable from that obtained by the use of ordinary electrodes. Total cerebral angiography was carried out by the method fully described previously [2]. In all investigations a 76% solution of urographin was used: 1 ml/kg body weight for adults and 1.2-1.3 ml/kg body weight for children. Different types of anesthesia were used: local in 3 patients, nitrous oxide-oxygen anesthesia in 5, fluothane-nitrous oxide-oxygen in 4, and superficial fluothane-nitrous oxide-oxygen anesthesia combined with injection of neostigmine and arfonad into the aorta in 4 patients. No complications were caused by angiography.

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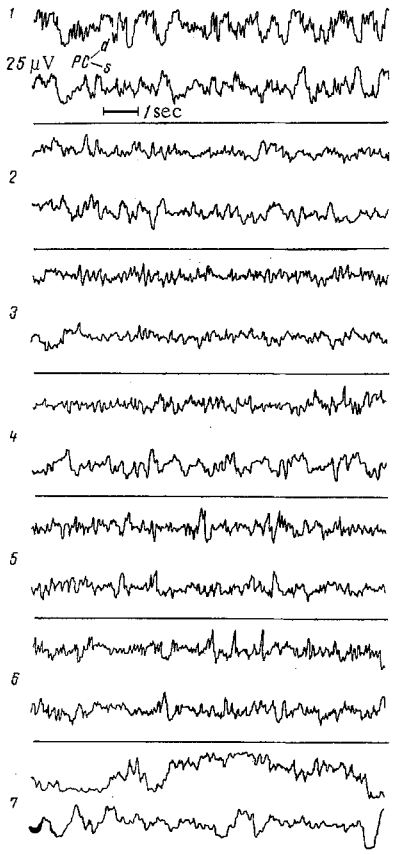

Fig. 1. EEG changes in patient R. during total cerebral angiography under nitrous oxide-oxygen anesthesia. 1) Hexobarbital induction; 2) initial background during nitrous oxide-oxygen anesthesia; 3) insertion of catheter into aortic arch; 4) 20 sec after insertion of catheter into aorta; 5-7) after injection of contrast material: 5) 10 sec; 6) 5 min; 7) 20 min.

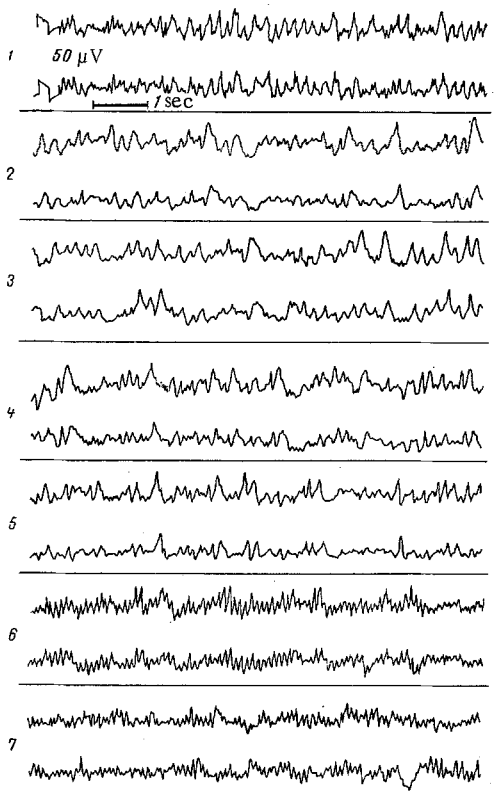

Fig. 2. EEG of patient L. During total cerebral angiography under fluothane-nitrous oxide-oxygen anesthesia. 4, 5) After injection of contrast material: 4) 10 sec; 5) 1 min. Remainder of explanation in text.

EXPERIMENTAL RESULTS

The character of the EEG on the 1st-5th days after total cerebral angiography differed depending on the pathological process. In patients with brain tumor, a decrease in amplitude of general cerebral delta-activity and of "bulbar" bursts of slow waves was observed. Focal slow waves in the projection zone of the tumor became more marked. These changes in all probability result from the dehydrating action of the contrast material. In patients with cerebrovascular lesions, a considerable increase in the fast waves and spikes was detected. The generation of these irritive changes in the EEG of these patients after angiography can be attributed to the fact that contrast material, when injected into the pathologically changed system of cerebral vessels, can irritate them still further and produce corresponding reflex changes in brain electrical activity. In patients with diffuse inflammatory changes, an increase in the slow waves on the EEG in all parts of the cortex was found after total cerebral angiography.

Electroencephalographic investigation during the first 5 days after angiography revealed the instability of these changes: they were maximal on the 1st day, much less marked on the 2nd-3rd day, and as a rule had disappeared by the 5th day.

Electroencephalography during total cerebral angiography yields objective data concerning the effect of the actual procedure of this investigation on the brain. Responses of the brain electrical activity differed depending on the character of anesthesia used for angiography. In this investigation, no relationship could

be discovered between these responses and the character of the pathological lesion. Definite changes in the EEG were observed in response to introduction of the catheter into the aorta, and also to injection of the contrast material, when local anesthesia was used, but the changes were less marked if nitrous oxide-oxygen anesthesia was used. Responses of the EEG desynchronization type (an increase in frequency and decrease in amplitude of delta-activity) during insertion of the catheter into the aortic arch (3) and in response to injection of the contrast material [5] in patient R. (with sequelae of encephalitis) during angiography under nitrous oxide-oxygen anesthesia are illustrated in Fig. 1. Changes of this type persisted for 20 sec after introduction of the catheter to the aorta and for 5-10 min after injection of the contrast material (6). Normal EEG indices were not restored until 20 min later: slow waves reappeared and the amplitude of the fast waves diminished (7).

During total cerebral angiography under fluothane-nitrous oxide-oxygen anesthesia or fluothane-nitrous oxide-oxygen anesthesia combined with administration of neostigmine and arfonad, no changes in the EEG were observed either during insertion of the catheter into the aortic arch or during injection of the contrast material. The EEG curves recorded during angiography on patient L. (diagnosis: saccular aneursym of the left anterior cerebral artery) are illustrated in Fig. 2. The initial background EEGs (1 and 2) show regular slow waves at 4-5/sec in recordings from both hemispheres (Robiner's stage III_1 of anesthesia). At the moment of insertion of the catheter into the aortic arch the character of the EEG remained as before (3). The EEG likewise was unchanged during injection of the contrast material (4, 5). The normal α-rhythm was restored on recovery from anesthesia (6, 7).

Changes in the EEG during total cerebral angiography were least when general (fluothane) anesthesia was used with the addition of intraarterial injection of the ganglion-blocking agent arfonad at the time of injection of the contrast material.

Investigation of the EEG showed that two brain responses arise during cerebral angiography: a transient response (10-15 sec) at the time of introduction of the catheter into the aorta, reflected in the EEG as synchronization, and a much more prolonged response (up to 20 min) to injection of the contrast material into the vascular system of the brain. These responses can be detected only if angiography is carried out under local or superficial general anesthesia. Under deep general anesthesia, or if superficial fluothane-nitrous oxide-oxygen anesthesia is combined with administration of ganglion-blocking agents, these EEG responses do not appear. The EEG response observed in these patients to mechanical stimulation of the interoceptors of the wall of the aortic arch is interesting. It can be considered as arising through a mechanism of a spread of excitation in response to arrival of impulses from the interoceptors along nonspecific pathways from the reticular system of the brain stem in the cortex. Phasic changes described by Kornienko [5] in cardiovascular activity at this period of angiography are presumably a component of the same general response of the EEG to superficial anesthesia. Both the first and the second EEG responses during total cerebral angiography take the form of generalized desynchronization reflecting an "arousal" reaction, and they arise as a result of influences from the reticular formation on the cortex. These responses differ essentially from the responses of cortical electrical activity to an acute disturbance of the blood supply to the brain, which have the form of slowing of the rhythm and increase in amplitude of the EEG waves [3, 12]. It must also be mentioned that during the period of the desynchronization responses of the EEG during total angiography, no signs of spasm of the cerebral vessels were seen on the angiograms, confirming the view that the electroencephalographic changes observed are reflex in origin.

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