Preliminary Communications

Measurement of Regional Blood Flow in Cerebral Cortex of Man through Intact Skull

Regional blood flow in the cerebral cortex has been measured in man by Lassen and Ingvar (1961) and Ingvar and Lassen (1961) using the krypton-85 clearance method developed by them.

Krypton-85, dissolved in saline, is injected over several minutes into the carotid artery. The gas diffuses almost equally between the blood and the brain. On cessation of the injection the krypton diffuses back into the blood, and the rate at which it is cleared from the brain tissue will depend on the quantity of blood perfusing the brain. There is no significant recirculation of the gas, as it is almost completely excreted in the lungs.

Since krypton-85 emits mainly beta particles with a range in tissue averaging 0.7 mm., this method can be used only on the exposed brain cortex, and so its clinical applications could only be limited. Ingvar and Lassen (1962) have suggested that this disadvantage could be overcome by using a gamma emitter, such as krypton-79. However, as this isotope emits very energetic gamma rays it is difficult to localize accurately the area of brain under study.

We have used the technique of Lassen and Ingvar but have substituted xenon-133 for krypton-85. This isotope emits a soft gamma ray of energy equal to 81 KeV. The xenon-133 is dissolved in saline and about 4 millicuries in 10 ml. is injected over two to three minutes into the internal carotid artery. The clearance of xenon-133 from the cerebral cortex is observed by means of a 5-in. (12.5-cm.) diameter scintillation detector and focusing collimator. The response of the collimator along the central axis is shown in Fig. 1. The collimator consists of two concentric circular tapered apertures, at an angle of approximately 30 degrees to the plane of the crystal. The collimator is made of lead and is $\frac{1}{4}$ in.

FIG. 1.—Response of collimator along central axis of detector.

(1.6 cm.) thick. A detailed description of this apparatus will be published in the near future.

The clearance curves obtained in a patient undergoing cerebral angiography for a suspected intracranial lesion, at two blood PCO_2 levels, are shown in Fig. 2. From the initial slopes, and assuming a value of 0.80 (B. Mallett and N. Veall, personal communication, 1962) for the partition coefficient of xenon between cortical tissue and blood, the flow is calculated as 0.75 ml./g./min. at a blood PCO_2 of 42, and 0.44 ml./g./min. at a blood PCO_2 of 20. This close relationship between blood flow and PCO_2 agrees well with results already obtained in dogs (Harper, Glass, and Glover, 1961) using the krypton-85 method. The measurement can be repeated within five minutes, and if necessary up to four measurements can be carried out on one patient.

Since a patient undergoing bilateral cerebral angiography will have up to 20 radiographs of the skull taken the additional radiation hazard due to the injection of xenon will be negligible owing to its biological half-life of the order of minutes and its inert character.

FIG. 2.—Clearance curves obtained on patient. The upper curve relates to a PCO_2 of 42, the lower curve to a PCO_2 of 20.

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