ELIMINATION OF SCALP BLOOD FLOW BY HEADBAND DURING DYNAMIC BRAIN SCINTIGRAPHY

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The effect of the application of a headband during brain scintigraphy was investigated in 11 healthy volunteers. In each person, extracranial recording of a bolus of ^{99m}Tc-pertechnetate injected intravenously was done on two occasions using a scintillation camera. On one occasion a narrow sphygmomanometer cuff encircling the head from brow to occiput and inflated to 300 mmHg was applied during measurements; another time, the procedure was identical except for the headband. A comparison between counting rates under the derived time–activity curves showed significantly lower values on headband application ($p < 0.01$). Static scintigrams consisting of the first 300,000 counts recorded after bolus release with and without headband application show a clear delineation of the headband position with prevention of "halo" appearance about the cranial cavity. It has thus been possible by simple means to reduce the irrelevant radionuclide distribution which, especially during dynamic investigations of cerebral circulation, constitutes a source of error.

By applying an electromagnetic flowmeter directly to exposed arteries at the time of neck dissection, it has been established that about 30% of the blood flow in the common carotid artery enters the external carotid artery and its branches (*1*). Some of these branches are located in the scalp and skull and the flow in these constitutes a source of error when extracranial measurements of the passage of a radioactive bolus through the head are performed in order to evaluate cerebral circulation. This has been emphasized by several authors (*2–4*) including ourselves (*5*). In patients suffering from cerebrovascular disease the scalp flow may even be enhanced and in cases of occlusion of the internal carotid artery this is often clinically evident, giving rise to the "external carotid artery sign" (*6*).

In order to minimize this error, areas of interest that exclude the cranial base, the sagittal sinus, and, as far as possible, the cranial wall are commonly used in investigations with computer-assisted scintillation camera equipment. For the most part, other measures have not been adopted in dealing with the problem.

When measuring regional cerebral clearance rates using ^{133}Xe inhalation and extracranial recording with and without the use of a headband, Mallett and Veall (*7*) found only an insignificant difference of less than 5% in the results. However, a report (*8*) stating that hair loss during cytotoxic treatment for various forms of malignancy can be prevented by using a headband prompted the present investigation because this finding indicates that a headband can exsanguinate the scalp effectively.

MATERIALS AND METHODS

Eleven healthy students volunteered to participate in the investigation and measurements were performed in each person on two separate occasions with an interval of 48 hr. Each time a bolus of 10 mCi ^{99m}Tc-pertechnetate in a volume of less than 1 ml was injected using the cuff-release technique (*9*), potassium perchlorate, 0.5 gm, having been administered orally 1 hr earlier.

In seven cases at the first examination, a narrow cuff (2 × 50 cm) closing with Velcro and encircling the head in a position immediately above the eyebrows, in the sulci between the scalp and the external ears, and to the occiput was applied. It was inflated to 300 mmHg just before the bolus was

Received Nov. 27, 1974; original accepted Jan. 23, 1975.

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released and deflated 3–4 min later without discomfort. At the second examination the headband was left out, the procedure being otherwise unchanged. In the remaining four cases the sequence was reversed.

The passage of the bolus through the head was recorded by a scintillation camera (Pho/Gamma III, High Performance, Searle Radiographics, 16,000-hole convergent collimator) with the collimator placed above the supine subject in the anterior projection. By means of the interfaced minicomputer (PDP 8/L, Digital Equipment Corp.) and the digital system (50/50 Nuclear Data Corp.) sequences of 0.5 sec were recorded during 1 min following bolus release and stored on a tape unit (Ampex TM7). Thereafter, areas of interest consisting of symmetrical regions for each hemisphere were selected. These were bounded inferiorly by the headband position and excluded the sagittal sinus, the vertex, and the lower lateral parts of the cranium. In each subject areas of equal size were selected at both examinations. Time–activity curves were then produced for each area of interest and the counting rates under the curves from bolus release to the time of curve maximum plus 1 sec were accumulated. The sum of accumulated counting rates from symmetrical areas of interest of one recording constitutes the parameter used in evaluating the headband effect and reflects primarily the activity during bolus arrival.

In addition, a static scintigram consisting of the first 300,000 counts recorded after bolus release was produced at each examination using a monitor oscilloscope and a Polaroid camera. The time elapsed before reaching 300,000 counts was registered.

RESULTS

Corresponding sums of accumulated counting rates in studies with and without headband application are shown in Fig. 1. Headband application leads to a significant reduction in registered activity ($p < 0.01$ Wilcoxon test) and the mean of the measured differences is 1,177 cps, which is 23.3% of the mean of sums of accumulated counting rates recorded without headband application. Figure 2 shows the obvious difference in the static scintigrams from the same subject, with headband (A) and without headband (B). Both consist of the first 300,000 counts registered after bolus release and the recording time was in (A) 4 min, 1 sec, and in (B) 2 min, 51 sec. A sharp transverse line reveals the position of the headband, which also prevents the usual "halo" appearance about the cranial cavity. In Fig. 2(B) a "halo" is present within 3 min.

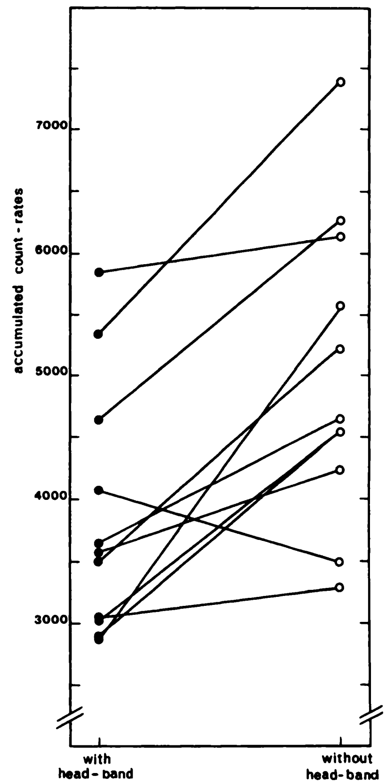

FIG. 1. Corresponding sums of accumulated counting rates in 11 subjects with and without application of headband.

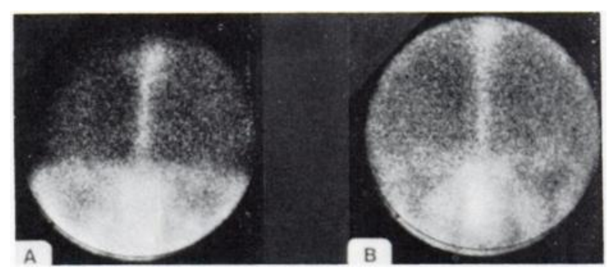

FIG. 2. Static scintigrams in same subject with (A) and without (B) application of headband. Both consist of first 300,000 counts recorded after bolus release.

DISCUSSION

It has been demonstrated that the characteristic "halo" about the cranial cavity appears gradually after the injection of ^{99m}Tc-pertechnetate and becomes dominant only after several minutes, suggesting that it originates largely from radionuclide in the extracellular fluid of the tangentially viewed scalp (*10*). The present investigation shows, however, that it is possible to exclude a part of the blood flow in the external carotid system and, furthermore, that this part contributes considerably to externally recorded time–activity curves. The static scintigrams show that the occlusion produced by the headband can be maintained during several minutes and that without headband a clearly visible "halo" appears within 3 min. These findings in combination suggest that the initial intravascular radionuclide distribution in the scalp is too substantial to be neglected.

Time–activity curves such as the ones described in this study are essential in cerebral transit time measurements. It must therefore be stressed that in patients with cerebrovascular disease, a relative enhancement of the flow in the external carotid system must be anticipated in consequence of cerebral occlusions. Time–activity curves from such patients will presumably be influenced by the interference of blood flow in the scalp to an even greater extent than those from normal persons. It must be mentioned that headband application does not affect circulation in the skull and it is conceivable that the occlusion of the scalp can produce some redistribution of blood from the external carotid artery into the internal carotid artery.

Our findings may seem to contradict those of Mallett and Veall, who found that the application of a headband with elimination of the scalp flow did not have any significant influence on the results of measurements of regional cerebral clearance rates in normal persons (*7*). It is, however, hardly appropriate to compare the results immediately because of the fundamentally different radionuclides employed as well as the different methods of analysis applied. The parameter of the ^{133}Xe measurements is the inclination of washout curves whereas accumulated counting rates under time–activity curves constitute the parameter in this study. The quoted finding does not affect the fact that in cerebral scintigraphy, it is in principle desirable to avoid irrelevant components in the measurement.

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