DIFFERENCES IN CHOROID PLEXUS CONCENTRATION OF PERTECHNETATE PRODUCED BY VARYING TIME OF PERTECHNETATE ADMINISTRATION AND BRAIN IMAGING

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To block effectively the uptake of pertechnetate by the choroid plexus, perchlorate may be given orally at any time before or after the injection of ^{99m}Tc-pertechnetate if administration precedes imaging by at least 60 min. Possible routes of discharge of pertechnetate from the choroid plexuses are back into the blood directly or indirectly through secretion with newly formed CSF.

Technetium-99m-pertechnetate is probably the most widely used radiopharmaceutical in clinical nuclear medicine practice today. Yet, there have been relatively few published reports of studies clarifying the body's handling of pertechnetate (*1–5*). This report is concerned with the kinetics of technetium pertechnetate concentration by the choroid plexuses as detected by scintillation camera images and alteration of this concentration by sodium perchlorate. We have attempted to define the rate of appearance of the radionuclide in the choroid plexuses as seen on brain images by varying the time of oral administration of perchlorate in relation to the intravenous injection of $^{99m}TcO_4^-$ and the time of imaging.

METHOD

Three hundred consecutive patients referred to the nuclear medicine service for brain scans were included in this study. Six groups of approx 50 patients each were defined (Table 1). All patients received 15 mCi of $^{99m}TcO_4^-$ intravenously. All groups were given 250 mg of oral sodium perchlorate except Group V, which received no perchlorate. Group I received perchlorate 20 min before the intravenous injection of the radionuclide; Group II, 30 min after injection; Group III, 60 min after injection. All groups were imaged at 120 min after the injection of the radioisotope, except Group VI, which was imaged at 150 min following injection of the radionuclide (i.e., 60 min after perchlorate).

All imaging was performed on a gamma scintillation camera (Searle Radiographics Model HP) utilizing a 25% window over the 140-keV peak. Technically unsatisfactory studies and examinations showing any abnormalities in the regions of the ventricles were excluded. All scintiphotos were interpreted by two physicians experienced in nuclear medicine. Each study was graded according to the amount of choroid plexus activity as follows: 0 = no uptake, 1+ = equivocal or uncertain uptake by the choroid plexuses, 2+ = definite but faint visualization of the choroid plexuses, and 3+ = definite and marked uptake by the choroid plexuses.

RESULTS

Figure 1 illustrates typical examples of categories 0 through 3+ choroid plexus uptake. The results of

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TABLE 1. PROTOCOL FOR PERCHLORATE ADMINISTRATION AND CAMERA IMAGING*,†

Group No.	Administration of perchlorate (min)	Imaging (min)
1	−20	+120
2	+30	+120
3	+60	+120
4	+90	+120
5	None given	+120
6	+90	+150

* Definition of the six patient groups according to time of administration of perchlorate and imaging related to time of injection of ^{99m}Tc-pertechnetate.

† Times are references to 0 minutes or time of injection of technetium-99m pertechnetate.

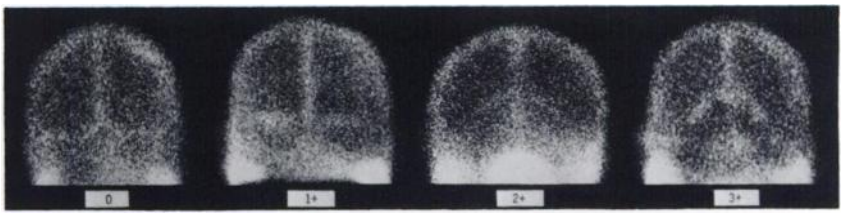

FIG. 1. Examples of categories 0–3+ choroid plexus uptake of ^{99m}Tc-pertechnetate on posterior brain scintiphotos. 0, No uptake, 1+, equivocal or uncertain uptake, 2+, definite but faint visualization, 3+, definite and marked visualization of choroid plexuses.

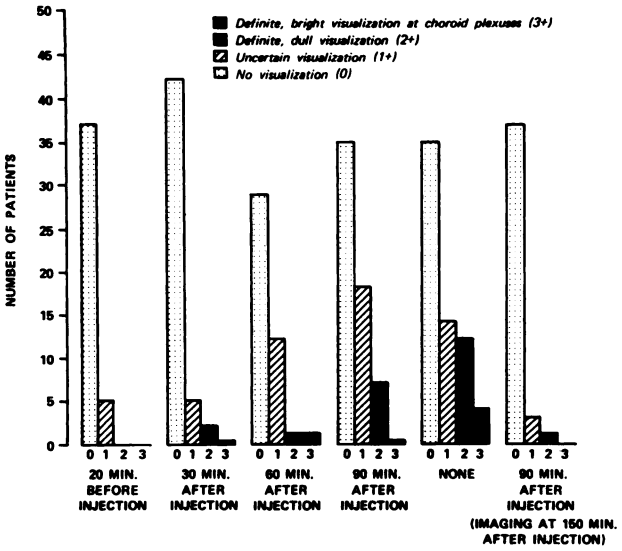

FIG. 2. Patients (300) included in study were distributed among the six groups as shown. Groups are defined in terms of time before or after injection of ^{99m}Tc-pertechnetate at which they received oral perchlorate. All groups were imaged at 120 min after injection of pertechnetate except Group VI, which was imaged at 150 min postinjection (60 min after administration of oral perchlorate).

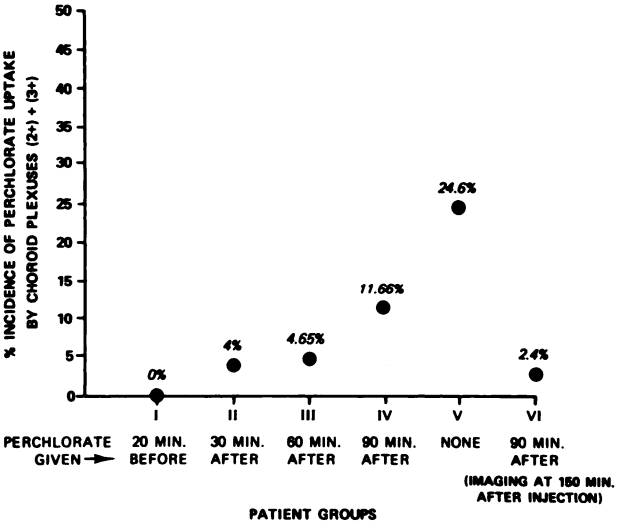

FIG. 3. Percent incidence of perchlorate uptake by choroid plexuses as defined by 2+ and 3+ visualization on brain scan (definite uptake) for each of six groups examined.

the study are shown in Fig. 2. In all groups the majority of the cases were without choroid plexus uptake of pertechnetate. In Group V (no perchlorate given) 35 patients showed no choroid plexus uptake whereas 14 additional patients showed "equivocal" uptake. Significantly more patients in this group were in categories 2+ and 3+ compared with the other groups. Only Group I (perchlorate 20 min prior to $^{99m}TcO_4^-$ injection) was without at least some 2+ and 3+ uptake. Figure 3 indicates the percent incidence of definite choroid plexus uptake (2+ and 3+) in patients of the six groups studied. A definite increased incidence of choroid plexus uptake in Groups IV and V is demonstrated as compared with all other groups. Figure 4 indicates the incidence of definite and "equivocal" choroid plexus uptake in the various groups by summing the 1+, 2+, and 3+ categories. The results follow the pattern seen in Fig. 4 with Groups IV and V showing the highest incidences of choroid plexus visualization.

The following are evident and noteworthy: 16/65, or 25%, of patients who received no perchlorate (Group V) had definite choroid plexus uptake (2+ and 3+) and 7/60, or 12%, of patients who received perchlorate at 90 min following the injection of the radionuclide (Group IV) had definite choroid plexus uptake. In contrast, only 2/41, or 2%, of patients in Group VI who also had perchlorate at 90 min following the injection of the radionuclide with imaging performed at 150 min after the injection (i.e., 60 min following the perchlorate) had definite uptake by the choroid plexuses.

DISCUSSION

This study suggests that if the perchlorate is given at least 60 min before brain imaging regardless of the time relationship to the radionuclide administration there is generally no detectable radionuclide concentration in the choroid plexuses on the brain scintiphotos. Groups IV and VI had perchlorate at 90 min after pertechnetate injection. Group IV was imaged 30 min after perchlorate was given and a relatively increased incidence of choroid plexus concentration of the radionuclide was seen. A much lesser incidence of choroid plexus visualization was

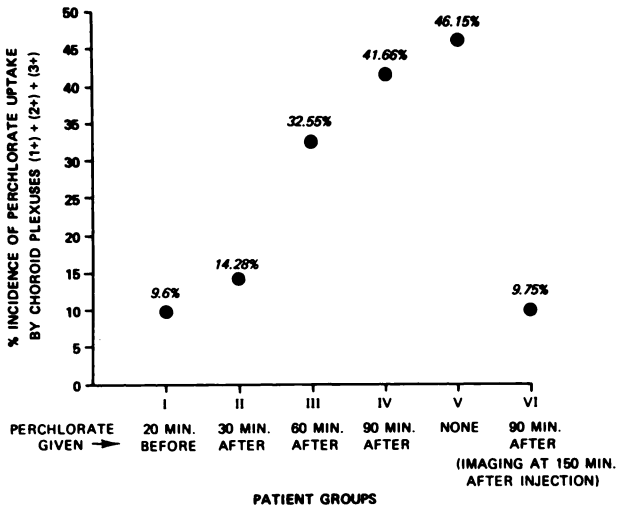

FIG. 4. Percent incidence of perchlorate uptake by choroid plexuses as defined by 1+, 2+, and 3+ visualization (definite plus uncertain visualization) for each of six groups examined.

evident in Group VI, which was imaged at 60 min after perchlorate administration.

The accepted mechanism of the blocking action of perchlorate against pertechnetate concentration by the choroid plexus is that of competitive inhibition (*6*). Intravenously administered pertechnetate is thought to bind to sites in the choroid plexus by an active transport process. The question then arises as to whether the pertechnetate ions displaced by perchlorate return to the blood or are secreted with the cerebrospinal fluid into the ventricles. Assuming the latter to be true, the pertechnetate would be present in the cerebrospinal fluid in a relatively low concentration, such that its presence in the ventricles, cisterns, and subarachnoid pathways would not be visualized on the scintillation camera brain image. This is supported by the fact that cerebrospinal fluid is formed at a rate of 0.37 ± 0.1 ml/min (*7*) so that in 60 min a total of approximately 20 cc is formed, a sufficient volume to replace the CSF contained in both lateral ventricles. Thus only a fraction of the total pertechnetate in the choroid plexus is transiently present in the ventricular cerebrospinal fluid at any given moment.

Silberstein and Levy (*8*) studied the distribution of intravenously administered ^{99m}Tc-pertechnetate in the blood, cerebrospinal fluid, brain, and choroid plexus of rabbits and determined that without perchlorate administration: (A) concentration of technetium in the choroid plexus exceeded the concentration in the brain by 16–70 times, (B) concentration of technetium in the choroid plexus exceeded that in blood by approximately 4.7 times, and (C) concentration of technetium in the choroid plexus exceeded that in the cerebrospinal fluid by 9–345 times. The effect of perchlorate in all cases was to diminish greatly the concentration gradient. There was complete obliteration of the CP/blood gradient while the CP/CSF gradient was halved. Harper, et al (*9*) reported that simultaneous administration of $^{99m}TcO_4^-$ and KC104 substantially reduced the localization of pertechnetate in the parotid, thyroid, and choroid plexus examined 2 hr later. Their experiments substantiated the finding that the $^{99m}TcO_4^-$: $NaClO_4$ solution produced a block which was as effective as oral perchlorate (100 mg) administered 2 hr before the $^{99m}TcO_4^-$. These animal data are in general agreement with the results of the human study reported here.

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