jnm / PRELIMINARY NOTE

INTRAVENOUS PERCHLORATE IN BRAIN SCANNING: EFFECTS ON CHOROID PLEXUS AND LESION VISIBILITY

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Intravenous potassium perchlorate pretreatment has been found to be safe and effective in doses of 2.7 mg in reducing choroid plexus accumlation of ^{99m}Tc-pertechnetate during brain scanning. Preliminary observations suggest that intravenous potassium perchlorate may enhance tumor visualization in some patients.

Brain imaging studies using radioactive ^{99m}Tc-pertechnetate have become established in the routine investigation of patients with suspected intracranial lesions, especially tumors. One of the problems with ^{99m}Tc-pertechnetate is its occasional localization in the choroid plexus causing difficulty in image interpretation. Choroid plexus visualization is minimized by the oral administration of 200–400 mg of potassium perchlorate ½–1 hr before the administration of intravenous pertechnetate, but this lengthens the time required for the study.

This paper reports on the role of intravenous perchlorate pretreatment in preventing choroid plexus pertechnetate uptake. Because perchlorate is thought to be a competitive inhibitor of pertechnetate, the subsequent investigation was expanded to assess if perchlorate would interfere with tumor uptake of pertechnetate.

MATERIALS AND METHODS

In the absence of a B.P. standard drug, 30 mg of potassium perchlorate (Merck's A.R. Chemical) was dissolved in 100 ml of pyrogen-free water for injection in a particle-free environment (Laminar Airflow Unit). Membrane filtration methods were used to achieve a particle-free water rinse. The solution was passed through a 1.2-micron Millopore filter and placed in neutral glass vials with rubber caps and aluminum closures. The sealed vials were then heat-sterilized at 115°C for 30 min and stored at room temperature.

Because the choroid plexus is inaccessible to direct study in vivo, and because of the known similarity between the mechanism of pertechnetate uptake in the two organs, the thyroid was chosen for preliminary studies. The effect of intravenous potassium perchlorate in doses varying between 0.05 and 3.0 mg on patient's thyroidal technetium uptake was assessed.

A 2-in. collimated NaI(Tl) crystal, connected to a suitable ratemeter and chart recorder, was placed 6 cm from the thyroid with the patient supine, and 1 mCi of ^{99m}Tc-pertechnetate was injected intravenously. Varying doses of potassium perchlorate were administered intravenously during the phase of thyroidal uptake of pertechnetate to see if the uptake could be halted. The dose of i.v. perchlorate required to discharge intrathyroidal pertechnetate after a plateau had been reached in the uptake curve was similarly determined on the other patients.

Brain imaging studies were carried out on a gamma camera (Nuclear-Chicago Pho/Gamma III) after 10–15 mCi of ^{99m}Tc-pertechnetate intravenously 45 min before imaging. Some patients were again imaged 3 hr after injection. Patients who exhibited significant choroid plexus pertechnetate uptake were restudied the following day, injecting the ^{99m}Tc-pertechnetate immediately after, or simultaneously, with a suitable dose (vide infra) of intravenous perchlorate; the injection-image interval was the same as that before perchlorate pretreatment.

The effect of intravenous potassium perchlorate on tumor visibility was determined in patients with clinical and scintigraphic evidence of intracranial tumors by studying them on a later day after simultaneous perchlorate and pertechnetate administra-

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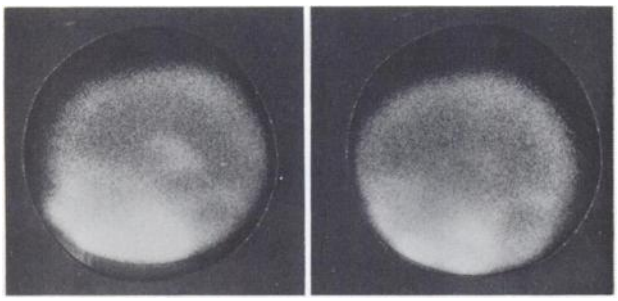

FIG. 1. Technetium-99m brain scan showing choroid plexus accumulation of radionuclide (left) and same patient scanned after perchlorate administration (right).

tion. The investigations were carried out using identical counting rates, intensity settings, and injection-image intervals.

RESULTS

Preliminary observations as described above revealed that 0.1 mg i.v. potassium perchlorate completely inhibits thyroidal uptake of pertechnetate and that 0.2 mg discharges most of the radioactivity already present in the pertechnetate-labeled thyroid gland. Subsequently, 2.7 mg (0.2 ml of an 1.33% solution) was used for the clinical studies. No side effects, neither local or systemic, were clinically observed at this dose level but severe transient local pain occurred when 50 mg or more of potassium perchlorate was injected. Because a single small dose of perchlorate was used, a search for hematological complications was not made.

In a 20-month period 1,315 patients had brain imaging studies and 14 had significant choroid plexus uptake (1%). Of these 14 patients, 11 were again imaged the following day with administration of i.v. perchlorate immediately before or simultaneously with pertechnetate. In ten of these patients, choroid plexus uptake was considerably reduced (Fig. 1) and in one patient there was no improvement. Three patients to whom intravenous perchlorate was administered after the initial pertechnetate imaging study did not exhibit significant radionuclide discharge from the choroid plexus.

Twelve patients with clinical and scintigraphic evidence of intracranial neoplasia were restudied after the pretreatment described above. In seven of the patients the visibility of the lesions improved (Fig. 2) whereas in five there was no improvement. Lesion visibility was not adversely affected in any patient. Two additional lesions, not seen in the initial study, were rendered visible by pretreatment in patients with intracerebral metastatic malignancy.

DISCUSSION

Previous observations have shown that oral potassium perchlorate prevents the choroid plexus accumulation of ^{99m}Tc-pertechnetate in humans (*1*) and intravenous perchlorate in dogs (*2*). The studies reported here suggest that intravenous potassium perchlorate is similarly effective in clinical use with no adverse effects. These studies confirm the observation (*2*) that perchlorate and pertechnetate can be administered simultaneously with economy in time and venepuncture. Since a waiting period is not required as after oral perchlorate, there is a reduction in the time required for the imaging study. Furthermore, with the intravenous route it is possible to pretreat even comatose patients whereas the administration of perchlorate tablets to such patients poses problems. Thus, the effectiveness of the intravenous route brings with it definite advantages. Although the administration of perchlorate as the potassium salt intravenously carries a theoretical hazard of hyperkalemia, this risk was considered negligible because 2.7 mg of potassium perchlorate contains only 0.76 mg of potassium. The choice of the potassium salt in this study was determined by its established use in oral pretreatment although recent observations (*2*) suggest that the sodium salt is likely to be equally effective. Because of its greater solubility, sodium perchlorate may prove to be the agent of choice for intravenous pretreatment.

Observations reported here show that only small quantities (0.2 ml or 2.7 mg) of intravenous potassium perchlorate are required to inhibit choroid plexus uptake of technetium. It has been suggested that perchlorate is a competitive inhibitor of pertechnetate (*3*); in view of this, the finding that small doses of intravenous perchlorate block choroid plexus pertechnetate uptake is not surprising since the weight of pertechnetate administered is small (10^{-10}gm/mCi).

Significant choroid plexus uptake of pertechnetate during brain scanning is relatively uncommon and varies from 1% in some series to 5–10% in others (*4*). Many observers suggest that as the choroid plexus rarely causes clinical difficulty, there is little

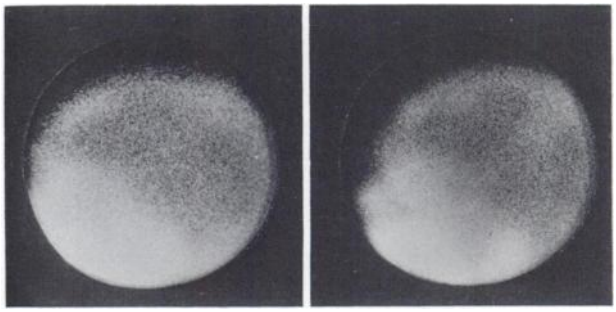

FIG. 2. Technetium-99m brain scans of same patient performed before (left) and after (right) perchlorate administration. Second picture shows at least two lesions.

point in routine perchlorate administration. However, 15–20% of brain tumors are not detected by technetium brain scanning (*5*). Though this figure can be improved by delayed scanning, any maneuver that enhances lesion visibility will be a useful addition to current techniques. In the present series it was found that intravenous potassium perchlorate pretreatment enhanced tumor visibility in 7 out of 12 patients; in 2 patients with intracerebral secondaries, additional metastases were seen after perchlorate pretreatment. Hence, it appears that perchlorate may enhance the efficacy of pertechnetate as a brain scanning agent.

The mechanism of perchlorate enhancement of tumor visibility is obscure, but some experimental basis can be found in the observations that intravenous perchlorate promotes an intracellular shift of pertechnetate in rabbits (*6*) and increases tumor technetium concentration in mouse brain sarcomas (*7*). Recently, autoradiographic studies have suggested that intravenous pertechnetate localizes almost exclusively within neoplastic cells in transplanted mouse gliomas (*8*) and in human acoustic neuromas (*9*). Studies are in progress to evaluate further the role of perchlorate in brain scanning.

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