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BRAIN SPECT WITH I-123-IODOAMPHETAMINE

Claude Raynaud

Service Hospitalier F. Joliot, Departement de Biologie, C.E.A.F 91406 Orsay

Brain SPECT entered into clinical use only recently when 123-I-Iso-propyl-Iodoamphetamine (IMP) became available[1-2]. This indicator penetrates the normal blood brain barrier (BBB) and for the first time places at the disposal of every nuclear medicine center some informations which until now, were provided only by positron emission tomography (PET) and reserved for priviliged centers. IMP SPECT is now considered very useful in epilepsy, in normal pressure hydrocephalus and probably in cerebral infarction.

Material and Methods

The SPECT systems now marketed can be classified under rotating-cameras, array-systems[3] and hybrid bar camera array system[4]. Rotating-cameras image the entire brain, due to their large detectors, but have low sensitivity and an acquisition time of 20 to 60 min. Array systems provide only transverse slices but have higher sensitivity. The hybrid system with its 3 transverse slices has a much higher sensitivity and a very short acquisition time of 1 to 4 minutes. For all these systems a thorough and weekly quality control of the gantry detector(s) and computer must be carried on.

To be used in brain, SPECT indicators must penetrate normal BBB and be labelled with gamma emitter. To have so far been proposed IMP and I23-I-Trimethyl Propane Diamine (HIPDM). Their specific activity varies between 1 to 10 mCi/mgr depending on the isotope producing company. Injected amounts vary from 2 to 7 mCi depending on the type of device used, IMP may be now labelled sing a kit[2].

Results – Application

After I.V. injection, the IMP brain activity curve reaches a maximum value of approximatively 6 to 7% of the injected dose after 30 minutes and remains in plateau for at least 24 hours[5-8]. With HIPDM the maximum brain activity value seems slightly lower[9].

Kuhl[6], Lassen[10], Devous[11], Holman[9] and Drayer[12] demonstrated that during the first ten minutes after injection the results obtained with IMP and HIPDM correlated significantly with regional cerebral blood flow (rCBF) and proposed the use of these indicators in measuring rCBF.

After 30 minutes, the brain distribution of IMP is modified. The results obtained by Lassen[10] on man suggested a redistribution. Devous[11] with HIPDM confirmed this redistribution on dogs and found poor correlation with rCBF. This new distribution of IMP and HIPDM seems to reflect metabolic activity of the brain rather than of the rCBF alone.

Results already published allow us to consider 3 main applications to IMP SPECT:

1. **In focal epilepsy**, during the interictal period, lesional and epileptogenic areas are hypoactive on IMP SPECT images[13-14] as they are on 18-F-Fluorodeoxyglucose PET image[15]. Recently in a group of 31 patients with focal epilepsy localized by electroencephalography and stereotactic-electroencephalography. Askienazy compared the results obtained with CT scans and IMP SPECT[16]. CT scans were positive in 73%, and negative in 27%: IMP SPECT provided correct localization in 73% and erroneous localization in 4%, it was negative in 4% and could not be interpreted in 19%. Although the proportion of IMP images which could not be interpreted is temporarily high, IMP SPECT seems to be the most promising atraumatic method of recognizing and localizing epileptogenic areas in focal epilepsy.

2. **In normal pressure hydrocephalus**, fronto-parietal and basal ganglia areas are hypoactive on IMP SPECT images[17]. After cerebrospinal fluid (CSF) drainage, Moretti found this hypoactivity unchanged in 10 patients and their clinical status not improved; in 7 patients the IMP

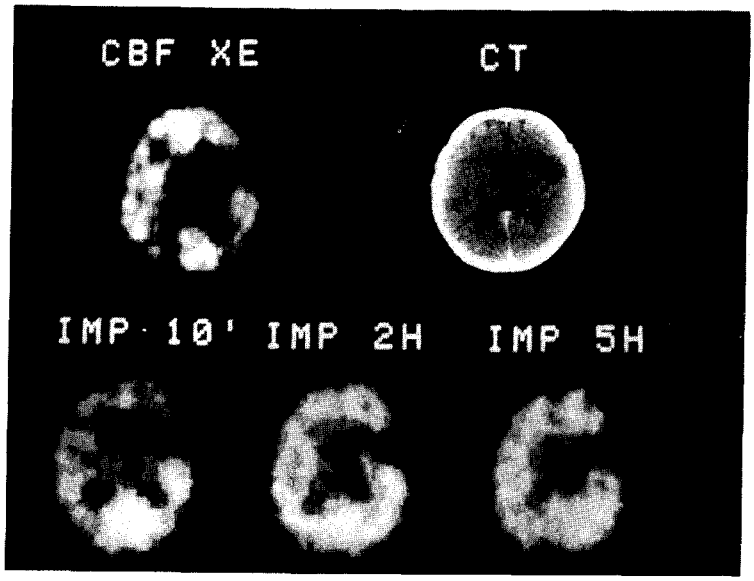

Fig. 1. Infarctus with persistent IMP hypofixation.
63 year old pateitn who 3 years earlier had a right sylvian infarct and hemiplegia. On the Xe-SPECT image the cortical and subcortical CBF decreased by 50% in the right frontal area compared with the contralateral area. On IMP SPECT images the IMP fixation of the corresponding area was low at 10 minutes, and still low at 2 hours and 5 hours, it was decreased by 43%, 42% and 45% at 10 minutes, 2 hours and 5 hours respectively. A right precentral hypodense area corresponds on the CT scan to this persistent hypofixation. CT scan, Xe and IMP SPECT images shown here were obtained at OM+60mn.

hypoactivity regressed or disappeared and the clinical status of most improved. The patients in the last group underwent surgical shunting and their clinical improvement was confirmed. Presently IMP SPECT seems to be of great help in selecting patients for surgical shunting.

3. In cerebrovascular infarction. Infarct areas are clearly seen as hypoactive areas on IMP SPECT images[5-14] (Fig. 1). With the high sensitivity SPECT system acquisitions could be routinely repeated due to the shortness of its acquisition time. We used 3 acquisition times, 10 min, 2 H, and 5 H, which provide a rough IMP kinetics. Two types of IMP kinetics were observed on infarcts[18]. In one the initial hypofixation persisted practically unchanged at 2 and 5 hours (Fig. 1); in the second the initial hypofixation improved with time so that the IMP fixation was plus or minus normal at 5 hours (Fig. 2). In "persistent" hypofixation a farily good correspondence was observed between IMP defects and CT hypodense area localization; rCBF measured with 133-Xe and in some cases, with 15-O_2, were largely decreased, with a mean decrease of about 50%. In "improving" hypofixation, the correspondence with CT lesions was poor or inexistent and the rCBF and $CMRO_2$, were only moderately reduced with a mean decrease of about 25%. These results suggest a definitive lesion in "persistent" hypofixation while in "improving" hypofixation

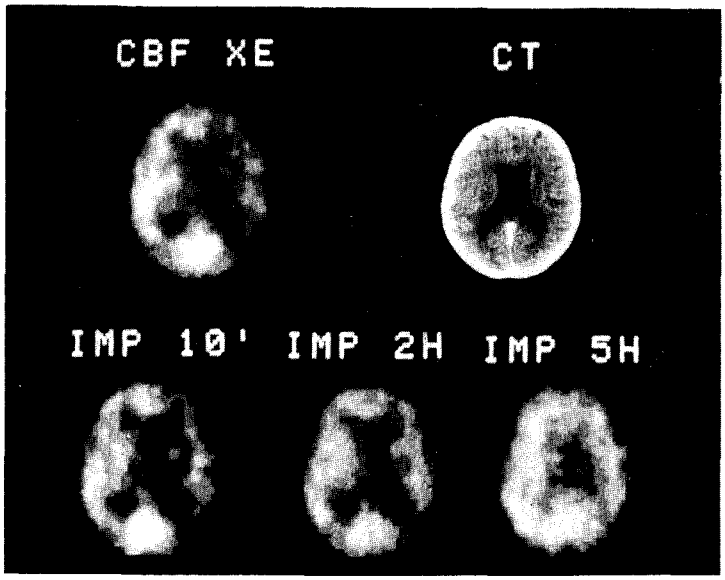

Fig. 2. Infarctus with improving IMP hypofixation.
50 year old patient who 18 months earlier had a right sylvian infarct with hemiplegia. On the Xe SPECT image the cortical CBF of the right sylvian area decreased by 24% compared with the contralateral area. On IMP SPECT images, the IMP fixation was low in the same area at 10 minutes, it improved at 2 hours and became almost normal at 5 hours. The fixation decreased by 15%, 10%, and 5% at 10 minutes, 2 hours, and 5 hours respectively, improving with time. In the right subcortical area, CBF was also decreased, IMP fixation at 10 minutes was low and remained low at 2 and 5 hours. This area of persistent hypofixation seems to correspond to the subcortical hypodensity visible on the CT scan. CT scan, Xe and IMP SPECT images shown here were obtained at OM+ 60mn.

they suggest a persistence of viable tissue.

4. Other applications. In very slowly evolving brain tumors such as low-grade astrocytoma, IMP SPECT is useful in determining the tumoral extension because CT images remain normal for a long period of time. In ALZHEIMER syndrome IMP SPECT should be as useful as 18-F-Fluoro-deoxyglucose, especially for early detection[19].

In conclusion, the usefulness of IMP (or HIPDM) brain SPECT is established for focal epilepsy and normal pressure hydrocephalus. Other applications are now being carefully studied including prognosis evaluation of cerebral infarcts which could become the most important application of the method in a near future. Such encouraging results demonstrate the utility of very short acquisition time SPECT systems and should also stimulate research for other BBB penetrating indicators labelled with gamma emitter, particularly with a higher brain concentration and (or) labelled with less expensive radio-isotope than 123-I.

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