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Usefulness of Brain SPECT ?

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SPECT is known to provide several advantages including three dimensional imaging, imaging of deep structures and the possibility of quantifying results. These advantages were not effectively exploited until new brain indicators labelled with gamma emitter and able to penetrate the normal blood brain barrier, such as I-123 isopropyl amphetamine (IAMP) and I-123 trimethyl propane diamine (HIPDM), became available. Under the term, "brain SPECT" we shall consider here only brain SPECT imaging obtained with these two indicators.

Results already published indicate that during the first ten minutes after injection, IAMP, and probably HIPDM, can be used as a regional cerebral blood flow (r CBF) indicator (D.E.KUHL (1), N.A.LASSEN (2), F. FAZIO, B.L.HOLMAN, B.DRAYER). Thirty minutes after injection, the distribution of IAMP or HIPDM is modified as indicated in dog by poor correlation between results obtained with both agents and r CBF, and in human patients by hypoactive areas corresponding to hyper-vascularized lesions. Most of the results published on IAMP and HIPDM refer to SPECT images obtained after 30 minutes and we will only consider such images in this paper, excluding early tomograms proposed for r CBF measurement.

I. Methodological considerations

IAMP and HIPDM are labelled with I-123 using commercial kits (ORIS-France) or by isotope-producing companies ; injected amounts vary from 2 to 8 mCi depending on the type of device used. Two SPECT systems are used, the detector array system and the rotating gamma camera. The detector array system provides only transverse slices but its major advantage is its high sensitivity. The rotating gamma camera offers the advantage of a large area detector and images the entire brain which can be studied after reconstruction on complete sets of parallel sections in transverse, sagittal and frontal planes. The major defect of the latter, is its low sensitivity which requires injections of high doses of indicator. Technical data has no place here. However, we must stress the need

for careful and frequent quality control of the device, of complete immobilization of the head, especially for rotating gamma cameras because the acquisition time is long (up to 30 or 60 minutes), and the need to place the head in the orbitomeatal position in order to use the data provided by brain anatomical atlas for anatomical localization. The same position should be used when X-ray CT scan is performed ; the same slices can thus be compared.

II. Applications

With IAMP and HIPDM, tumor or infarct ara expressed by hypoactive areas on tomogram slices (3) whatever the vascularization of the lesion. The size of the hypoactive area is generally larger than on the scan, indicating probably the functional repercussion of the lesion on surrounding tissues. Main applications of brain SPECT appear to be cerebro-vascular patients, epilepsy and some cases of tumor.

1. Cerebro-Vascular Patients

Infarctus visualized on X-ray CT scan are quite visible on SPECT sections but other hypoactive areas can be observed which are not visible on X-ray CT scan. The detection of these hypofunctional areas is useful in order to establish a functional evaluation of the cerebral parenchyma. Such a test seems useful in patients with an impairment of the cognitive function, associated or not with ischemic hemiplegia, in establishing the prognosis of stroke rehabilitation, in differentiating degenerative dementia and multi-infarct dementia, and, above all, in long-term amnesic syndrome of hippocampal origin. It should also be useful in asymptomatic bilateral internal carotid occlusion before determining the usefulness of surgery or pharmacological treatment (fig. 1), in transient cerebro-vascular accidents, in determining the functional state of the whole brain (fig. 2), and in some infarctus where it may be necessary to appreciate for therapeutical purposes the functional state of the brain. Brain SPECT appears as an atraumatic functional test which is a useful complement to arteriography, X-ray scan and r CBF.

2. Epilepsy

Results obtained with IAMP indicate that in epileptic patients, excluding brain tumor patients, lesional and epileptogenic areas are hypoactive. Localization of these territories correlates quite well with more accurate neuroradiological or stereotaxic techniques. In these patients, IAMP proved to be the more sensitive atraumatic method.

3. Brain tumors

They can be detected very easily by other methods and it is clear that IAMP SPECT is not the best method. However, the possibility of obtaining a complete brain image on transverse, sagittal and frontal sections may be very useful in determining the extent of a tumoral lesion on deep structures such as thalamic nuclei or basal ganglia which are well delineated on frontal and sagittal sections. It also facilitates the spotting of stereotaxic biopsies.

Although the experience of research teams working with IAMP (and HIPDM) is quite restricted due to the high cost of the indicator, some applications now appear to be worth the cost and in some cases provide data which cannot be obtained with routine techniques, especially in cerebro-vascular patients and in epilepsy. This should encourage research of other indicators of brain parenchyma and, above all, of the hippocampal area.

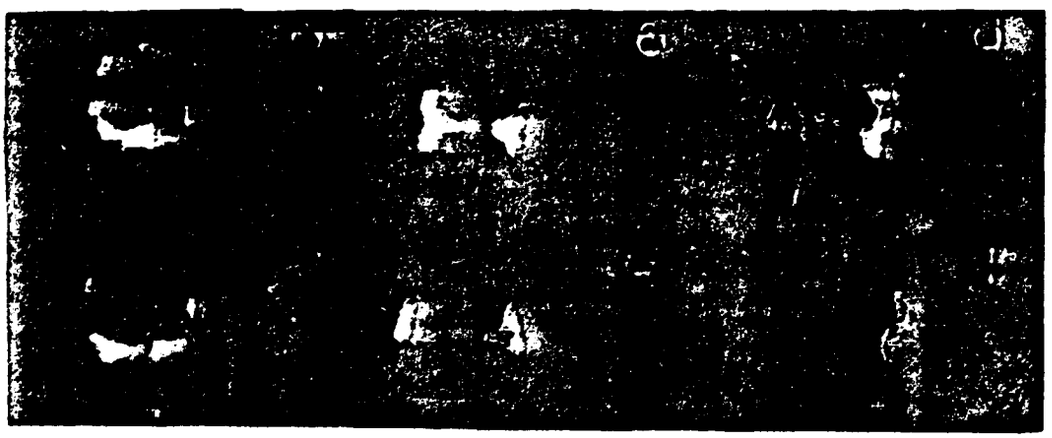

Figure 1. Mr T.J. is a 50-years-old patient with aymptomatic bilateral carotid occlusion. X-ray scan showed moderate cortical atrophy without parenchymal lesions. On IAMP SPECT sections, four areas are hypoactive of which two are shown here, one is left prerolandic (upper images), the other is located in deep right temporal region (lower images). The latter appears extended to T4 and T5. Transverse, frontal and sagittal sections are respectively shown from left to right on this figure.

Figure 2. Mr D.R. is a 60-years-old patient with right anterior sylvian reversible ischemic neurological deficit (RIND) who was examined 15 days after onset. On X-ray scan a right superficial sylvian infarct and the scar of an old infarct in the caudate nucleus are visible. On IAMP SPECT, a right hypoactive area corresponds to the sylvian infarct but is much larger than on CT and is extended to rolandic and high rolandoparietal region (upper images). Two other hypoactive areas are clearly seen, one on left parietal lobe and the other on deep temporal region extending to basal ganglia and hippocampal area (lower images). Transverse, frontal, and sagittal sections are respectively shown from left to right on this figure.

References

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LA GAMMATOMOGRAPHIE CEREBRALE EST-ELLE UTILE ?

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La gammatomographie cérébrale (GTC) n'a pu être réellement exploitée que lorsque l'iodo-amphétamine-I-123 (IAMP), indicateur capable de traverser la barrière hémato-méningée normale, a été disponible.

Le prix élevé de la molécule et la faible sensibilité des systèmes tomographiques ont pu masquer les avantages de la GTC, notamment la possibilité d'étudier la totalité du cerveau et non seulement quelques coupes et la possibilité de faire un bilan de la valeur fonctionnelle du parenchyme cérébral avec un examen atraumatique. L'expérience acquise montre que cet examen apporte des informations pratiquement irremplaçables dans la pathologie vasculaire cérébrale, l'épilepsie, et dans certains cas de tumeur. Ces résultats complètent sans les remplacer ceux qui sont obtenus par les méthodes traditionnelles telles que l'artériographie, le scanner X et la mesure des débits sanguins cérébraux régionaux.

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