Developpement moderne de la resonance magnetique (imagerie et spectroscopie).

Seance de la Societe Francaise de Neurologie. 1990 Nov 9; Marseille, France.

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Mr. Chairman,
Ladies and Gentlemen,

It is a great pleasure to talk here in front of this auditory about the recent developments in MR-imaging and spectroscopy applied to cerebrovascular disease. In the following few slides I would like to elaborate the role of magnetic resonance considering brain morphology, macrocirculation and tissue metabolism.

Slides 1 and 2:

There is a multiplicity of causative possibilities to create cerebral ischemia, which is macrocirculation, microcirculation, embolism, oxigennation, the metabolic results within the ischemic tissue is characterized by anaerobic glycolysis, disfunction of the cell membrane, ion disbalance and development of a cytotoxic edema.

In relation to the duration of ischemia the extent of ischemia cell death may not occur within the whole ischemic regions, but there might be sparing of some regions giving way to the discussion of penumbra and definite ischemic event. The goal using magnetic resonance is in the 1990's to diagnose ischemia at the earliest possible time to obtain vascular information considering the macrocirculation and to accurately define tissue loss. Furtheron spectroscopy may reveal direct metabolic information of ischemia.

Slides 3 and 4:

On the left side you can see a patient with a cortical signal abnormality in the T2 weighted images, involving the cortex of the posterior MCA territory about 3 hours after onset of right hemiparesis and aphasia. Beneath the acute cytotoxic edema some chronic ischemic changes in the right parietal region are well

seen. Based on our experiences the sensitivity of MRI in ischemic stroke can be defined higher than CT with positive ischemic findings in time periods of less than 4 hours. Therefore MRI should be the modality of choice in acute ischemic disease of the brain. The specifity of MRI in ischemia is based on signal behaviour in hemorrhage, which allows a staging of the time course, based furtheron to anatomical distribution. In case of multiple lesions, however, signal behaviour does not allow specific diagnosis.

Slides 5 and 6:

All patients were examined on a 1.5 T Magnetom using a circular polarized headcoil with a field of view (FOV) from 20 to 25 cm. The imaging protocol consisted of spinecho and gradient echo sequences, and in selected patients a spectroscopy using a stimulated echo technique was performed.
In order to use magnetic resonance imaging at the earliest possible time an increased number of critically ill patients has to be evaluated. Therefore an adequate monitoring of the vital functions has to be garanted, acquiring pulse oximetry, ECG, blood pressure, capnography. For imaging conventional spinecho sequences in two orientations and different weightenings were obtained. New techniques, like special flow sensitive FISP and FLASH gradient echo sequences, allow in a threedimensional acquisitions visualization of complex intracranial and extracranial vasculature.

The use of gradient echo sequences allowed to minimize Pixel size (1+1+1 mm) resulting in a nearly isotropic resolution. These images can be further evaluated by computerized postprocessing.

Slides 7 and 8:

The left side shows a critically ill patient after severe right side pontine infarction. On the right side axial T2 weighted images show a pathological area with signal intensity into the pontine structures related to an ischemic infarction.

Slides 9 and 10:

In the left slide there is a patient with a huge MCA infarction in the anterior territory. One of the questions for the clinician would be to estimate the exact degree of tissue loss in the patient. In order to obtain maximal accuracy it would be necessary to acquire the data with a resolution of less than 1 mm in plane and about 1 mm in slice thickness. Using a 3D FLASH sequence data of this resolution can be obtained in the time periods of 15 to 20 minutes. In the right slide the brain of the previous patients, has already been extracted from the surrounding soft tissue and the skull and the actual volume of the supratentorial brain was calculated (1007 ml).

Slides 11 and 12:

On the left side brain volumes of the supratentorial hemispheres are calculated and separately volumetrically postprocessed. These slices can be used to reconstruct the brain surface where the ischemic on the left side is well shown.

Slides 13 and 14:

Based on the shown examples the sensitivity of MRI in ischemic stroke can be defined higher than CT in time periods of less than 4 hours. Segmentation of infarct volume allowed a quantification of loss volume and in follow up studies randomization of stroke trials. The surface reconstruction can be used for neurophysiologic relation like EEG, brain mapping, also infarct and brain topography can be visualized.

On the second part of may talk I would like to extent to further applications of magnetic resonance, like MR-angiography and MR-spectroscopy.

Since 1987 we investigated MRA in cerebral macrocirculation. Flow related enhancement depends on the in flow of unsaturated spins and flow compensation by refocussing gradients. The sequence parameters were adjusted to maximize contrast between moving blood and stationary tissue. The examination time for MR-angiography is less than 10 minutes and it is important to mention that no contrast agent is used. Postprocessing reveals projectional angiograms.

Slides 15 and 16:

On the left side you can see a patient with a MCA infarction in the posterior territory of the right side. On the right slide FLASH 3D compensation of the regional flow sensitive FISP images does not show flow induced signal within the right carotid artery. (deshalb die linke ICA hell, die rechte dunkel).

Slides 17 and 18:

After reconstruction of the MR-angiographic pictures into 3D-projection the occlusion of the right carotid artery is well shown. In conclusion MR-angiography permits a reliable visualization of normal vessels. As this type of noninvasive examination is sensitive to stenosis and occlusion MRA may be of tremendous importance with respect to grade III of clinical investigations as well as an impact of clinical management.

Slides 19 and 20:

In attempts to gain a metabolic information within ischemia with proton spectroscopy it is now possible to obtain actual metabolic data from infarcted tissue.

For water suppressed proton magnetic resonance spectroscopy there were used STEAM sequences, where a volume from 16 to 27 ml is investigated.

Slides 21 and 22:

This is a patient 4 hours after acute onset of aphasia and right hemiparesis. T2 weighted images show already cytotoxic and vasogenic edema of the left hemisphere. The spectrum was obtained from a 27 ml Voxel. The obtained spectrum clearly shows a huge resonance of lactate proving the anaerobic glycolysis in the ischemic area. N-acetyl-aspartate (NAA) is diminuished to about half of the normal size. Creatine and phosphocreatine remains at normal levels, probably due to anaerobic glycolysis. Choline which reflects membrane compounds should not be changed in infarctions and is preserved at a normal level.

Slides 23 and 24:

The same patient was examined 5 days later. On the T2 weighted images the demarcation of the infarct can be seen. The metabolic information on the proton spectra shows a further increase of the lactate indicating that anaerobic glycolysis is furtheron active. Creatine begins to decrease as well as NAA is further decreased related to the demarcation of the infarct.

Slides 25 and 26:

With the use of magnetic resonance spectroscopy noninvasive observation of anaerobic glycolysis is possible as well as evaluation of NAA allows an assessment of viable neurons.

These metabolic information indicated that in case of acute infarction there is actual a therapeutic window when the nerve cells are preserved in the structural metabolism by anaerobic glycolysis, but when anaerobic glycolysis persists for a too long time secondary tissue damage due to acidosis will occur. In order to initiate a therapy as soon as possible acute metabolic infarction is necessary.

The potential of MR-spectroscopy is to monitor directly therapeutic effects on the metabolism of ischemic brain.

Slides 27 and 28:

In conclusion MR offers an improved sensitivity to acute stroke and to small ischemic lesions, it allows the accurate location and delineation of ischemia especially with respect to the posterior fossa.

In the diagnosis of the cerebrovascular disease the clinician predominantly needs information about morphology, macrocirculation and metabolism and it is shown on the right side, that MRI is capable to answer all these questions in a single and completely noninvasive examination, sufficient for clinical management. The method allows also a new indication with noninvasive angiography and has a monitoring capability using volumetry and MR-spectroscopy. So the question may arise if management and research in stroke will not be justified without modern MR-technologies.

Thank you for your attention.

SOCIÉTÉ FRANÇAISE DE NEUROLOGIE

Réunion de Marseille

Paris, octobre 1990

La prochaine séance de la Société Française de Neurologie aura lieu le

VENDREDI 9 NOVEMBRE 1990

à l'Amphithéâtre de l'Université
Jardin du Pharo, 13007 Marseille

Ordre du jour

Séance du matin à 11 h

Confrontation anatomo-clinique
P. Trouillas, D. Vincent, Ch. Duyckaerts. — Instabilité à la marche, incoordination, détérioration progressive et hépatomégalie chez une femme de 67 ans.

Déjeuner de travail
Villa Gaby, Corniche Kennedy

Séance de l'après-midi à 14 h 30

D. Cros, J.F. Pellissier. — Neuropathie porphyrique avec rhabdomyolyse.

S. Nurick. — Les résultats psychologiques d'une hemorragie meningée par rupture d'un anévrysme de l'artère communicante antérieure.

R. Labauge, R. Sankey, M. Pages, J.M. Blard. — Seminome thalamo-pedonculaire. A propos d'un cas.

Ch. Tranchant, M.H. Dugay, B. Lannes, Ph. Wasser, M. Mohr, J.M. Warter. — Un cas de forme familiale d'amyotrophie spinale et d'atrophie pallido-luyso-nigrique avec inclusions de type corps de Lewy.

J.M. Leger, M. Levasseur, N. Benoit, J.C. Baron, S. Tran-Dinh, F. Bolgert, L. Cohen, P. Brunet, J.L. Signoret. — Apraxie d'aggravation lentement progressive : etude par IRM et tomographie à positons dans 4 cas.

L. Milandre, B. Bonnefoi, P. Pestre, J.F. Pellissier, F. Grisoli, R. Khalil. — Dolichoectasies arterielles vertébro-basilaires. Complications et pronostic.

G. Besson, J. Bogousslavsky, F. Regli, P. Maeder. — Le syndrome pseudo-bulbaire aigu.

R. Gherardi, C. Mhiri, M. Baudrimont, F. Gray, J. Poirier. — Le spectre des vascularites nerveuses et musculaires au cours de l'infection par le VIH.

F. Gray, M. Mohr, L. Chimelli, P. Clavelou, F. Scaravilli, J. Poirier. — Leucoencephalopathie fulminante ressemblant à une sclérose en plaques aiguë, revélatrice de l'infection par le VIH.

A. Alicherie, J. Bille, J.L. Gastaut, R. Khalil, M. Poncet, J. Pouget, G. Salamon, G. Serratrice. — Contribution à l'étude de l'anatomie fonctionnelle du cerveau.

Th. Crepin-Leblond, A. Majdalani, J.C. Gautier. — Comparaison du scanner X et de l'imagerie par resonance magnétique après des accès ischémiques transitoires.

I. Berry, C. Mekies, C. Bensemhoun, C. Louis, C. Manelfe, A. Rascol, M. Clanet. — Analyse IRM longitudinale des lésions dans la SEP : aspects morphologiques et quantitatifs.

F. Gerstenbrand. — Développement moderne de la resonance magnétique (imagerie et spectroscopie).

H. Gastaut, G. Serratrice, R Khalil, J.L. Gastaut, G. Salamon. — Contribution à l'exploration IRM de l'epilepsie temporale.

Étant donné l'importance du programme, le temps de parole sera strictement limité à 10 minutes.

Réception au Palais du Pharo à 19 h

SAMEDI 10 NOVEMBRE 1990

Journée à Aix-en-Provence
(retour à l'aéroport et à la gare assuré).

Les personnes accompagnantes sont conviées aux diverses manifestations.
Pour renseignement, s'adresser à Madame Vidal-Naquet, service du Professeur Serratrice,
La Timone, Marseille, tél. 91.49.38.65.