行政院國家科學委員會補助專題研究計畫成果報告

※※※※※※※※※※※※※※※※※※※※※※※※※
※ ※
※ 亞急性腦中風的灌流影像及擴散影像的臨床意義及預後

The clinical significant of perfusion and diffusion images
in subacute cerebral infarct

※
※ ※
※※※※※※※※※※※※※※※※※※※※※※※※※

計畫類別：X個別型計畫 □整合型計畫
計畫編號：NSC89-2314-B002-272-M08
執行期間：89年8月1日至90年7月31日

計畫主持人：廖漢文

共同主持人：王堯弘、黃永堅

本成果報告包括以下應繳交之附件：
- □赴國外出差或研習心得報告一份
- □赴大陸地區出差或研習心得報告一份
- □出席國際學術會議心得報告及發表之論文各一份
- □國際合作研究計畫國外研究報告書一份

執行單位：台大醫學院放射線科

中 華 民 國 90 年 10 月 30 日

一、中文摘要

背景：在台灣地區，每年會發生近 2 萬例的腦血管疾病，並高居十大死亡原因的第二位。其中腦缺血占其中的 60%~75%。並有逐年增加的趨勢。部份病患會在急性期死亡外，大部份均會慢慢變成亞急性或慢性。灌流影像及擴散影像近年來一均被認為乃診斷超急性及急性腦中風的最新及最準確工具，但有關亞急性病患及臨床意義未見有研究。

方法：使用臨床病患分別使用超音波或磁振血管攝影了解其大血管阻塞情形。並合併同時作 H-MRS 灌流影像及擴散影像。然後依其結果作分析，可知不同病患之灌流影像及擴散影像有不同的模式及圖形，由此推算病患的預後及可能的變化。

本計劃分為三年：

１、 第一年：收集亞急性腦中風病患約五十名、並在彼等的檢查結果分別作出基本圖形分析。

２、 第二年：再收集亞急性腦中風病患病患一百名、並加上述五十名結果成立一小資料庫。開始分析第一年的五十名的預後。

３、 第三年：全面分析前面共一百五十名病患的結果，並統計彼等間的相關關係。

第二年計劃已在 89 年度獲得通過。此乃第二年結果。

關鍵詞：腦中風、磁振造影、灌流影像、擴散影像

Abstract

Background: More than 20,000 new cases of cerebrovascular diseases occurred annually in Taiwan area. It becomes the second most common cause of death in this country. Among them, 60% to 75% were ischemic stroke with a trend increasing every year. Except for those cases will die in acute stage, all of the rest become subacute or chronic stage. In recent, diffusion and perfusion imagings are considered as latest and the most accurate tool for the diagnosis of hyper-acute and acute ischemic cerebral diseases. However, their clinical role in the subacute and chronic stage is not studied yet.

Method: With Doppler and MRA, we can study the status of the steno-occlusive change of the major cerebral vessels. In the same time, we can perform the H-MRS perfusion and diffusion imaging in them. With analysis of the data, we may categorize the patients into different group according their different combination of the patterns of perfusion and diffusion imagings. From this we can evaluate and predict the prognosis of each patient.

This plan can be divided into 3 year:

1. We can collect about 50 cases with subacute infarct, basic analysis according to their perfusion and diffusion imaging can be performed in the 1st year.
2. In the 2nd year, we have to collect 100 more cases and make a data bank, and analysis the prognosis of the first 50 cases.
3. In the 3rd year, we have to analysis the perfusion and diffusion imagings, clinical, and outcome in the 150 patients, and calculate their statistic relationship.

Keywords: Cerebral ischemia, Magnetic resonance image, perfusion image, diffusion image

Background and purpose:

More than 20,000 new cases of cerebrovascular diseases occurred annually in Taiwan area. It becomes the second most common cause of death in this country. Among them, 60% to 75% were ischemic stroke with a trend increasing every year. Except for those cases will die in acute stage, all of the rest become subacute or chronic stage. In recent, diffusion and perfusion imagings are considered as latest and the most accurate tool for the diagnosis of hyper-acute and acute ischemic cerebral diseases. However, their clinical role in the subacute and chronic stage is not studied yet.

Diffusion-weighted MRI (DWI) is highly sensitive in detecting early cerebral ischemic changes in acute stroke patients. In this study we compared the sensitivity of DWI with that of conventional MRI techniques. Furthermore, we investigated the prognostic value of the volume of ischemic lesions on DWI scans and of the apparent diffusion coefficient (ADC). Shortly after the onset of an ischemic stroke,

the ADC of brain tissue is significantly reduced because of cytotoxic edema. Over several days, the rapid initial drop in ADC is followed by a return to "pseudonormal" values at approximately 1 week. Subsequently, elevated ADC values are seen at chronic time points. DWI is remarkably sensitive in detecting and localizing acute ischemic brain lesions and allows differentiation of acute regions of ischemia from chronic infarcts. Recent studies have shown a high correlation between the volume of early DWI lesions and clinical neurologic outcome. In addition, the volume of the early DWI lesion correlates well with final infarct volume as measured by T2-weighted imaging. Therefore, this technique may facilitate optimal selection of patients for new medical therapies for stroke and may provide a highly sensitive technique for evaluating the efficacy of new treatments.
During the first hours of stroke evolution, the regions with abnormal perfusion are typically larger than the DWI lesions, and this mismatch region has been suggested to be "tissue at risk."

Method and materials
With analysis of the data, we may categorize the patients into different group according their different combination of the patterns of perfusion and diffusion imagings. From this we can evaluate and predict the prognosis of each patient.
This plan can be divided into 3 year:

1. We can collect about 50 cases with subacute infarct, basic analysis according to their perfusion and diffusion imaging can be performed in the 1st year.
2. In the 2nd year, we have to collect 100 more cases and make a data bank, and analysis the prognosis of the first 50 cases.
3. In the 3rd year, we have to analysis the perfusion and diffusion imaging, clinical, and outcome in the 150 patients, and calculate their statistic relationship.

Results (2st year)
Three patterns of abnormalities were seen:

1. PWI lesion larger than DWI lesion (70/150; 46.6%),
2. PWI lesion smaller than DWI lesion (17/150;11.3%),
3. DWI lesion but no PWI lesion (46/150; 30.7%).
4. DWI lesion equal to PWI lesion (17/150;11.3%),

1. In pattern 1 (PWI lesion larger than the DWI lesion predicted DWI expansion into surrounding hypoperfused tissue ($p < 0.05$).This is the high risk group with possibility of evolution of stroke (TIA in 10 patient sin this study, frank infarct in same vascular territory in 4 patients in the 50 patient in the 1st year study)
2. In pattern 2, the area of DWI is not enlarged in follow-up and 2 patient in 50 patient in 1st year experience of TIA(boderzone?)
3. In pattern 3, they were most lacuna or small vascular lesion and in 2 of the patients experice acute stroke again in the 1st followed of the 50 patients.
4. This group was not in 1st year study.

Discussion

Combination of PWI and DWI in the prediction of infarct volmne change performed but Liu et al.They concluded that:

1. The tissue proceeding to infarction during the follow-up had significantly lower initial CBF and cerebral blood volume values on PWI maps ($P < 0.001$) than the eventually viable ischemic tissue had.
2. The best value for discriminating the area of infarct growth from the eventually viable ischemic tissue was 48% for PWI relCBF and 87% for PWI relative cerebral blood volume.

Ueda et al studied twenty-five ischemic lesions were detected during the acute phase, and 14 of these were confirmed as infarcts on follow-up images. Both ADC and rMTT maps had a higher sensitivity (86%) than the rCBV map (79%), and the rCBV map had the highest specificity (91%) for detection of infarction as judged on follow-up images. The rMTT and ADC maps tended to overestimate infarction size (by 282% and 182%, respectively), whereas the rCBV map appeared to be more precise (117%). Significant differences were found between ADC and rMTT maps, and between rCBV and rMTT maps. They concluded that all three techniques are sensitive in detecting early ischemic injury within 72 hours of symptom onset but tend to overestimate the true infarction size. The best methods for detecting ischemic injury and for estimating infarction size appear to be the ADC map and the rCBV map, respectively, and the diffusion abnormality may indicate early changes of both reversible and irreversible ischemia.
Takashima et al determined clinical features of patients who had a profound hemispheric hypoperfusion with relatively small, acute cerebral

infarcts. One hundred and thirty-five patients with acute cerebral infarction underwent both magnetic resonance imaging (MRI) and cerebral blood flow (CBF) measurement in the acute phase of stroke. Eleven (8.1%) had a profound hemispheric hypoperfusion with relatively small infarcts. In these patients, magnetic resonance angiography or conventional angiography was performed, demonstrating the internal carotid artery (ICA) stenosis or occlusion on the ipsilateral side of the infarcts. MRI and CBF measurement were repeated one month later. All of 11 patients suffered from a mild consciousness disturbance, and showed a progress of neurological symptoms during a few days, indicative of a progressing stroke. Five patients of 11 concomitantly had atherosclerotic lesions in the arteries distal to the circle of Willis. The remaining six patients had only the ICA lesions. The prognosis of the former was poor and the hemispheric hypoperfusion pattern did not improved. On the other hand, the prognosis of the latter was good and the hemispheric hypoperfusion was recovered soon. In conclusion, if the collateral flow through the circle of Willis could compensate the misery perfusion, the prognosis of low-flow infarctions with ipsilateral ICA lesions might be good.

Karonen et al using combined diffusion-weighted (DW) and perfusion-weighted (PW) MR imaging in 49 patients with acute (<24 hours) stroke, on the 1st and 2nd days and 1 week after stroke. Volumes of hypoperfused tissue on maps of relative cerebral blood volume (rCBV), relative cerebral blood flow (rCBF), and mean transit time (MTT) were compared with the volume of infarcted tissue at DW imaging.

1. The mean infarct volume increased from 41 to 65 cm(3) between the 1st and 2nd days (P: <.001; n = 49). On the 1st day, all perfusion maps on average showed hypoperfusion lesions larger than the infarct at DW imaging (P: <.001; n = 49). MTT maps showed significantly (P: <.001) larger hypoperfusion lesions than did rCBF maps, which showed significantly (P: <.001) larger hypoperfusion lesions than did rCBV maps. (MTT>rCBF>vCBV>DWI between the 1st and 2nd days).
2. The sizes of the initial perfusion-diffusion mismatches correlated significantly with the extent of infarct growth (0.479 < r < 0.657; P: </=.001).
3. The hypoperfusion volume on the initial rCBV maps correlated best with the final infarct size at 1 week (r = 0.891; P: <.001).

References

Liu Y, Karonen JO, Vanninen RL, Ostergaard L, Roivainen R, Nuutinen J, Perkio J, Kononen M, Hamalainen A, Vanninen EJ, Soimakallio S, Kuikka JT, Aronen HJ. Cerebral hemodynamics in human acute ischemic stroke: a study with diffusion- and perfusion-weighted magnetic resonance imaging and SPECT. J Cereb Blood Flow Metab 2000 Jun;20(6):910-20

Ueda T, Yuh WT, Maley JE, Quets JP, Hahn PY, Magnotta VA.Outcome of acute ischemic lesions evaluated by diffusion and perfusion MR imaging. AJNR Am J Neuroradiol 1999 Jun-Jul;20(6):983-9

Takashima S, Taguchi Y, Inoue H, Hirade S, Nagahori T.A profound hemispheric hypoperfusion with relatively small infarcts indicates a progressing stroke. Keio J Med 2000 Feb;49 Suppl 1:A77-9

Karonen JO, Liu Y, Vanninen RL, Ostergaard L, Kaarina Partanen PL, Vainio PA, Vanninen EJ, Nuutinen J, Roivainen R, Soimakallio S, Kuikka JT, Aronen HJ. Combined perfusion- and diffusion-weighted MR imaging in acute ischemic stroke during the 1st week: a longitudinal study. Radiology 2000 Dec;217(3):886-94