Clinical value of dipyridamole brain perfusion imaging in the diagnosis of ischemic cerebrovascular disease

ZHANG Rong, WEI Wen-Shi, TANG Xi,GU Zhao-Xiang, JIANG Mao-Song

(*Huadong Hospital, Shanghai 200040*)

Abstract Using dipyridamole stress test to evaluate cerebral blood flow reserve in cerebrovascular disease (CVD). Dipyridamole stress tests were performed first, the baseline SPECT images were obtained under similar conditions 2–5 days later. By visual and semiquantitative analysis, the responses of cerebral blood flow to dipyridamole were divided into the following four patterns: A: The dipyridamole SPECT showed an expanded area of hypoperfusion, Asymmetry Index(AI) and Uptake Rate(UR) were all decreased; B: Rest images was normal but new hypoperfused areas appeared on stress test with decreased AI and UR; C: Hypoperfused areas were decreased in size or disappeared after stress test with increased AI and UR; D: No changes showed in cerebral perfusion imaging patterns, and in AI and UR between stress and rest studies. Dipyridamole brain perfusion imaging may be helpful to the diagnosis of CVD, to the decision the therapeutic plan, and to predicting the therapeutic effect.

Keywords Cerebral ischemia, Tomography, Emission-computer, Single-photon, Dipyridamole

CLC numbers R817, R74 A

1 INTRODUCTION

The cerebral perfusion in many CVD patients with the decreased reserve was still normal. Dipyridamole is a potent and useful vasodilator, which can increase the cerebral blood capability. This study wanted to use dipyridamole stress test to evaluate cerebral blood flow reserve in CVD, then to improve the clinical value of brain perfusion imaging in the diagnosis of ischemic CVD.

2 SUBJECT AND METHODS

2.1 Study objects

There were 8 normal controls (2 women and 6 men, mean 63.36±8.70 years) none had neurologic or cardiac problem such as diabetes, hypertension or peripheral vascular

Manuscript received date: 2002-01-07

disease. 66 patients with CVD (15 women and 51 men, mean 65.15±11.49 years) included 21 transient ischemic attacks (TIA) and 45 cerebral infarct (CI) patients.

2.2 Study protocol

All subjects were performed dipyridamole stress test first. Dipyridamole was given intravenously at a dose of 0.14 mg· $kg\cdot^{-1}min^{-1}$ over 4 min followed by administration of 740 MBq ^{99m}Tc-ECD, then the brain SPECT scanning was performed after 30 min using SIEMENS ORBITAL/ICON SPECT system. The SPECT heads were equipped with low-energy, high resolution, parallel collimators. Sixty-four projections with an imaging time of 30 sec per projection were obtained. 2 pixels thick cross-sections were reconstructed as transaxial, coronal and sagittal view by backprojection and use of a butterworth filter in 64×64 matrixes. Blood pressure, heart rate and EKG were monitored in whole process. The baseline SPECT scan was performed 2–5 days after the dipyridamole study. Both baseline and dipyridamole SPECT scans were obtained under similar environmental condition.

8 patients of the subjects were followed after clinical treatment (3-5 months later) with CT and/or MRI, the brain SPECT imaging.

3 IMAGING ANALYSIS

3.1 Visual analysis

2 nuclear medical doctors blinded to the patients' history qualitatively assessed the SPECT images and CT scans. Unilateral lesion was compared with the radioactive distributions of the symmetric regions in contralateral hemispheres; bilateral lesions were evaluated the radioactive distribution in comparison with the near relatively normal brain. The dipyridamole stress tests and baseline images were observed the changes of the radioactive distribution simultaneous. Normal dipyridamole stress test and baseline images are symmetric in both hemispheres. Compromised CBF reserve is defined as a reduced perfusion in one hemisphere or focal location, and normal CBF reserve as an increased focal perfusion after dipyridamole injection.

3.2 Relative quantitative analysis

Both sides of frontal, temporal, parietal and cerebella were clearly showed in the 3 rd, 7 th, and 11 th transaxial planes. Both hemispheres were divided into same volume ROIs. ROIs were calculated as gamma counts per pixel in all ROIs. The mirror part of lesion in contralateral hemispheres or relatively normal region was taken as referring area. Method: (1) AI (asymmetric index)=(average counts per pixel in hypoperfused hemisphere average counts per pixel in normal or relatively normal hemisphere)/ average counts per pixel in normal or relatively normal hemisphere. AI reflects changes of CBF in both lesion and normal hemisphere before and after dipyridamole injection. (2) UR (uptake ratio)=average counts per pixel in lesion ROIs / average counts per pixel in contralateral normal ROIs. UR reflects changes of CBF before and after dipyridamole injection.[1] The normal range of baseline and stress test was 0.90–1.00. The lesion was defined as UR<0.90.

4 RESULTS

4.1 The results of control group

There was no difference of average counts between dipyridamole test and baseline brain perfusion image in both hemispheres of control group (t=1.88, p >0.05). The value of UR of both hemispheres with stress test and rest image in control group was more than 0.90, no difference was found between them (t=2.15, p >0.05).

4.2 Visual analysis

The results of dipyridamole brain perfusion test were divided into four types. Type A (27cases, 4 TIA, 23 CI): The areas of primary lesions increased in size after injection. Type B (11 cases, 8 TIA, 3CI): Areas of marked hypoperfusion appeared after injection. Type C (23 cases, 6 TIA, 17CI): The lesions became reduced in size or disappeared after injection (Fig.1). Type D (5 cases, 3 TIA, 2 CI): No difference was found in both baseline and dipyridamole tests.

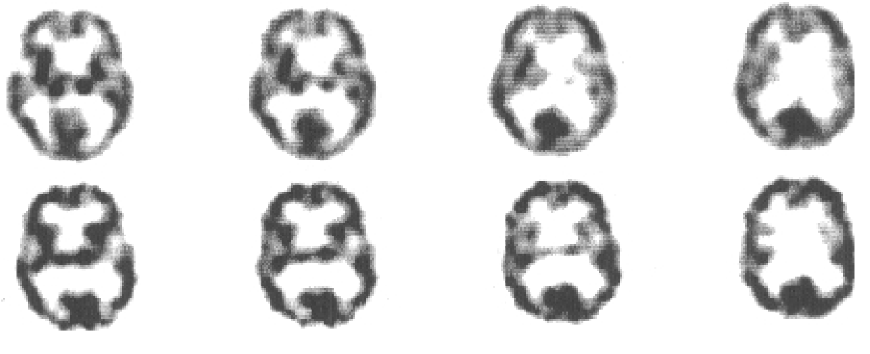

Fig.1 Type C: The lesions (left and right frontal, temporal) became reduced in size or disappeared after injection

4.3 Table 1 shows the results of the relative quantitative analysis

Table 1 The changes of AI and UR in four types with dipyridomole and baseline images in CVD patients

Tape	Asymmetric index (AI)			Uptake ratio (UR)		
	DPD	Baseline	p	DPD	Baseline	p
A(27)	-0.113±0.019	-0.074±0.009	<0.05(2.41)(1)	0.79±0.05	0.84±0.01	<0.05(2.56)(1)
B(11)	-0.068±0.019	0.014±0.023	<0.01(11.8)(2)	0.86±0.02	0.92±0.07	<0.01(5.17)(2)
C(23)	-0.035±0.007	-0.079±0.023	<0.01(8.92)(2)	0.88±0.04	0.83±0.05	<0.05(2.44)(1)
D(5)	-0.076±0.012	-0.08±0.014	>0.05(2.34)	0.86±0.06	0.85±0.03	>0.05(1.89)

NOTE: DPD= Dipyridamole stress test. The dates in brackets were t. Compared with baseline tests, (1)$p<0.05$, (2)$p<0.01$

4.4 Cross cerebellar diaschisis (CCD)

CCD was found in 14 of 45 CI cases. 8 cases recovered after injection of dipyridamole.

4.5 Follow up

8 of CI patients were followed up after treatments and were checked again. Five cases of type A showed enlarged ischemic areas in rest images after treatment, the value of UR decreased. The lesions reduced in size and UR increased after treatment were found in three of type C.

5 DISCUSSION

There is much importance to evaluate brain vascular reserve in patients with cerebrovascular disease for early diagnosis, evaluation of efficacy of treatment and prognosis. Techniques, such as angiography, CT, MRI and routine brain perfusion image, can not definitely observe the brain circulation reserve. The usefulness of evaluating cerebrovascular disease with acetazolamide stress brain perfusion SPECT has been well demonstration.[2,3] As there is no injection agent of ACZ in our country, we used dipydamole as an alternative stress agent to assess CBF reserve.

The results of type A with CI showed poor brain reserve in ischemic area. It suggests that the brain perfusion of the lesion and this hemisphere is lower than that of baseline level, the other possibility may be an intracranial steal phenomenon that shifts flow from ischemic area or hemodynamic deficient area to normal areas.[4] In type B cases, the brain perfusion was kept normal by compensated cerebrovascular dilation in rest state. Insidious ischemia might be present in these areas, the vessels could not be dilated even with dipyridamole. The CBF were normal in type C for their relatively good vessel reserve. The good collateral circulation and vascular responsibility can well compensate the low focal metabolism caused by ischemia in baseline state. The degree of ischemia had no significant changes both in visual analysis and in quantification analysis before and after dypiradamole stress test in type D. Whether it was a poor vascular response needs further study.

TIA is an aura of cerebral stroke, CT and MRI usually find no abnormalities (the positive rate of CT and/or MRI is only 26.3% in our TIA group). The results showed: The brain perfusion reserve of type A is poor. The detected rate increased (from baseline 54% to 85%) in type B. The lesions improved markedly or recovered normal in type C. It demonstrates that transient cerebral artery occlusion or vascular spasm causes most of these TIA attacked, they are risk factors of stroke.

CCD is mostly found in patients with cerebral infarction.[2] Fourteen cases of CCD were found in our study, 8 cased recovered after dipyridamole injection. It suggests that the cerebellar blood supply has not been damaged.[5]

The symptoms, such as dizziness, nausea, and blush, were found in fifteen cases, no special treatments were taken. However it needs to carefully monitor ECG, blood pressure and heart rate. There were no severe complications in our study. Dipyridamole was contra indicated in patients with unsteady angina, acute muscle infarction, bronchial asthma, and acute cerebral infarction.

References

1 LIN X T, SONG W Z, LIU Y C *et al.* Chin J Nucl Med, 1989, **9**:217-220
2 ZHOU Q, LI F, ZHAO Y B. Chin J Nucl Med, 1998, **18**:7-10
3 XIU Y, CHEN S L, SUN X G *et al.* Chin J Nucl Med, 1998, **18**:11-13
4 Hwang T L, Saenz A, James J *et al.* J Nucl Med, 1996, **37**:1595-1599
5 Sakashita Y, Matsuada H, Kakutta K *et al.* Stroke, 1993, **24**:84-87