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Deterministic Implication of Acetazolamide Stress Brain Perfusion SPECT - A Case Report

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Abstract

Background: Assessment of cerebrovascular reserve (CVR) by acetazolamide (ACZ) stress brain perfusion SPECT aids to choose appropriately between cerebral revascularization surgery and medical management. Aim of this report was to describe deterministic implication of brain perfusion SPECT with per oral ACZ stress as our initial experience.

Case Presentation: We report a case of 30 years old lady presented with five month history of left sided hemiplegia. While digital subtraction angiography showed total occlusion of left common carotid artery as the reason of her left middle cerebral artery territory infarct, ACZ stress brain perfusion SPECT revealed presence of moderate perfusion reserve. Finally, the surgeons refrained from the option of cerebral revascularization surgery, kept her under medical management to observe improvement of neurological deficits on short term clinical follow up. Another ACZ stress brain perfusion SPECT after two years showed comparative improvement of her perfusion deficit.

Conclusion: This case is an example of deterministic implication of ACZ stress brain perfusion SPECT for choosing an appropriate management strategy in patients with cerebrovascular ischemic disease in conjunction to conventional imaging modalities.

Keywords: Acetazolamide; Brain Perfusion; SPECT; eZIS; Tc-99m-ECD

Abbreviation

CVR: Cerebrovascular Reserve, ACZ: Acetazolamide, SPECT: Single Photon Emission Computed Tomography, ECD: Ethyl Cysteinate Dimer, HMPAO: Hexamethylpropyleneamine Oxime, DICOM: Digital Imaging And Communications In Medicine, ezis: Easy Z Score Imaging System. MCA: Middle Cerebral Artery, SPM: Statistical Parametric Mapping, 3D-SSP: Three-Dimensional Stereotactic Surface Projections, ROI: Region Of Interest, SPAM: Statistical Probabilistic Anatomical Mapping

Background

Degree of stenosis in carotid or cerebral arteries cannot be correlated with cerebral perfusion reserve in cerebral ischemia due to presence of compensatory contribution from autoregulatory vasodilatation and collateral flow from neighboring territories. Assessment

of cerebro-vascular reserve from baseline and acetazolamide stress brain perfusion SPECT can categorize the candidacy for cerebral revascularization surgery versus medical management in cerebral ischemia depending on finding of compromised or preserved CVR respectively. This is a report of a candidate of cerebral revascularization surgery who after revelation of preserved cerebral perfusion reserve was instead put to medical management ensuing favorable outcome.

Case Presentation

A 30 years old female with no previous history of hypertension or dyslipidemia, with five months old left middle cerebral artery territory infarct with right sided hemiplegia was referred to neurosurgery department of a tertiary teaching hospital from a peripheral secondary healthcare center. Digital subtraction angiography revealed total blockage of left common carotid artery up to one centimeter beyond bifurcation with poor collateral from other vessels. A plan for cerebral revascularization by external/internal carotid bypass surgery was made. Meanwhile, with an aim to evaluate cerebrovascular reserve she underwent an ACZ stress brain perfusion SPECT.

Brain perfusion SPECT was performed using a single day split dose baseline-post ACZ protocol (Figure 1). Radio tracer used was Tc-99m ECD. Image acquisition was done with a dual head SPECT. For ACZ challenge, 1250 mg of tablet was crushed and administered orally. Raw image reconstruction was done by filtered back-projection using Butterworth filtering without attenuation correction. Baseline and post-ACZ SPECT DICOM images were reoriented into Talairach space using NeuroGam (Segami Corporation) in the processing terminal (Figure 2). In addition, All the DICOM images were transferred to personal computer to analyze using easy Z-score imaging system (eZIS) v3.

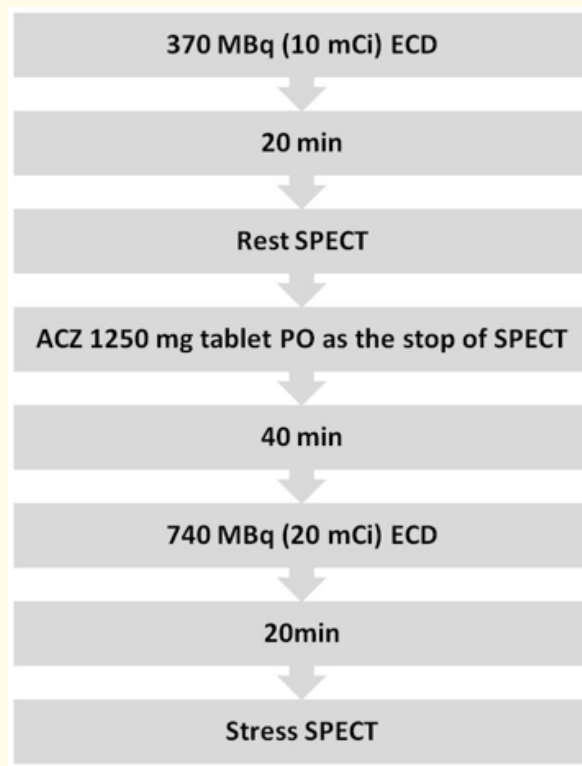


Figure 1: Protocol used for ACZ challenge brain SPECT at NINMAS.

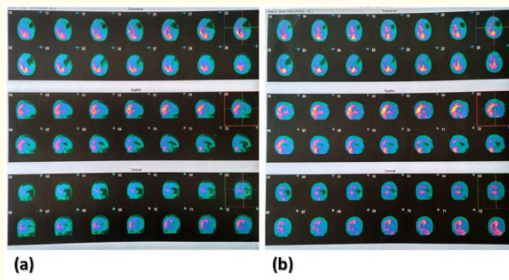


Figure 2: Reoriented DICOM images with NeuroGam (a) Baseline and (b) post ACZ.

Baseline images showed a big area of perfusion deficit in left fronto-temporal region with reduced perfusion in ipsilateral basal ganglia, thalamus as well as in left frontal lobe; indicating infarct in left middle cerebral artery (MCA) territory. Normal cerebral perfusion was maintained in right hemisphere (Figure 3).

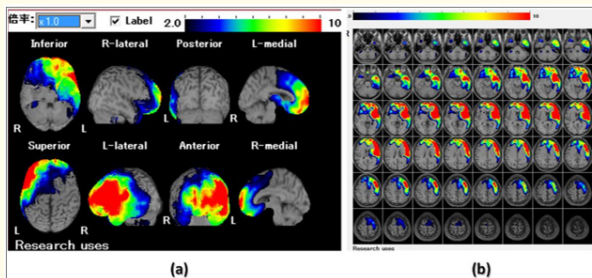


Figure 3: Baseline results of eZIS analysis (a) surface view and (b) axial multislice images showing big photon deficient area in left fronto temporal region with reduced perfusion in ipsilateral basal ganglia, thalamus and frontal lobe; indicating infarct in left MCA territory.

Post ACZ images showed increased perfusion in left frontal lobe, left hemi-thalamus including in the peri-infarct area in left MCA territory; resulting in diminution of the perfusion deficit area (Figure 4) in comparison to the baseline images. Thus, a qualitative assessment of type II response was made which indicated presence of a moderate perfusion reserve in left MCA territory.

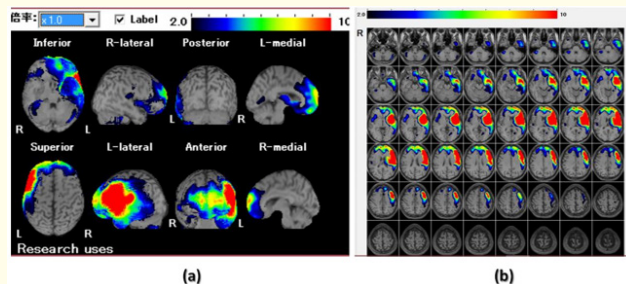


Figure 4: Post ACZ results of eZIS analysis (a) surface view and (b) multislices images showing diminution of the perfusion deficit area in left MCA territory in comparison to the baseline images.

Based on these findings, the surgeons refrained from choosing the option of cerebral bypass surgery and the patient was kept under medical management. Improvement of neurological deficits was seen on a clinical follow up after 4 months. Another ACZ stress brain perfusion SPECT was performed on this same patient after two years. The baseline images show perfusion defect in the same area (Figure 5) which was however smaller than before followed by improved perfusion in after ACZ administration (Figure 6); altogether suggesting improved perfusion reserve.

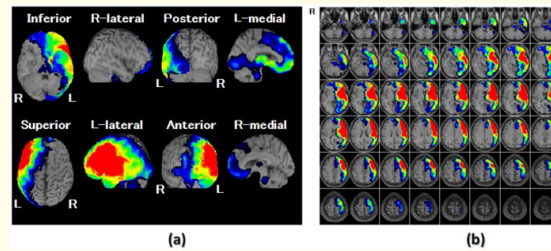


Figure 5: Follow up in the same patient after two years; Baseline images eZIS analysis (a) surface view and (b) axial multislice images

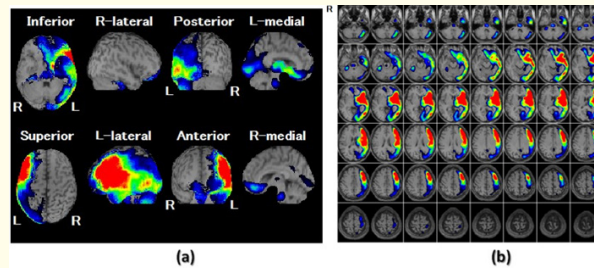


Figure 6: Follow up in the same patient after two years; post ACZ images eZIS analysis (a) surface view and (b) axial multislice images.

Discussion

The present case was a completed stroke with common carotid occlusion in need for pre-operative evaluation of cerebrovascular reserve prior to carotid shunting. All the conditions comply with those mentioned in the guidelines [1,2] and hence a brain perfusion SPECT using ACZ was appropriately indicated.

The tracer used was ECD. For brain SPECT with ACZ challenge, ECD is more sensitive than HMPAO for lesion detection and lesion-to-normal contrast [3]. This is because ECD in comparison to HMPAO is radiochemically more stable [4] and has a lower rate of back-diffusion from brain to blood [5].

We have used one day split dose baseline-post ACZ protocol. The two day protocol was avoided because of the high patient to camera ratio of the institute. The one day protocol described by Matsuda, *et al.* [6] could have been more time saving as well as technically more accurate as it does not require removal of patient from camera-bed. The one day protocol described by Knop, *et al.* [7] is the one with lowest radiation dose.

While the SNM and EANM guidelines recommend intravenous administration of ACZ, no intravenous ACZ is available in Bangladesh. This case was done using oral ACZ following reports of oral ACZ administration at doses of 1.2 - 2 gm [8,9].

eZIS is a validated and recommended tool for evaluation of brain perfusion SPECT [10]. Mizumura, *et al.* [11] identified eZIS as superior to statistical parametric mapping (SPM) developed by Friston, *et al.* [12] and three-dimensional stereotactic surface projections (3D-SSP) developed by Minoshima, *et al.* [13]. The SPM and 3D-SSP although, offers objective as well as reproducible analysis, unlike eZIS are dependent on a normal database and are unable to avoid effects of aging, atrophy.

Other remarkable quantitative measurements include computer-aided analysis method [14], parametric CVR imaging [15] and radionuclide angiography incorporated regional cerebral blood flow measurements [16,17]. Visual qualitative evaluation of hemodynamics by baseline-ACZ stress SPECT was reported to be subjective and hardly reproducible [18]. Semi-quantitative methods for evaluation CVR with manually drawn region of interest (ROI) or statistical probabilistic anatomical mapping (SPAM) provided reliable descriptive parameters [19], albeit rather found to be operator dependent and of limited for assessment of anatomical extent and spatial information.

According to the classification of Rogg, *et al.* [20], our patients had a type II response on post ACZ images compared to that of baseline. While a compromised CVR is amenable to cerebral revascularization surgery, patients having preserved CVR can improve with medical management [20]. Thus, medical management was favored over surgery in our patient which resulted in observance of favorable outcome.

Conclusion

This was the first brain perfusion SPECT with ACZ as well as the first experience of using eZIS for evaluation of CVR in Bangladesh which was clinically influential because the course of management was changed resulting in a satisfactory outcome.

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Informed Consent

Informed consent was obtained from the patient who is the subject of this report.

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Conflict of Interests

No competing financial interests exist.

Institutional Ethical Committee Approval

IEC approval was obtained.

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