

Brain scintigraphy in brain death: The experience of nuclear medicine department in dokuz eylul university, school of medicine

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Abstract. We investigated the propriety between the findings of brain death scintigraphy and the patient outcomes after the scan. We figured out the benefits of scintigraphic findings to the diagnosis. This study was performed in our department between 2006-2011 and patients were evaluated retrospectively. Pre-diagnosis of brain death and final diagnosis were compared.

24 patients were referred to our nuclear medicine department between 2006-2011. All patients underwent brain scintigraphy following IV injection of 20 mCi of Tc 99m DTPA or 10 mCi Tc 99m HMPAO with one-second dynamic images in 128x128 matrix for a period of 60 seconds. Anterior, posterior, right and left lateral static images were obtained with 5-minute in 256x256 matrix after dynamic images. Patients were referred by the departments of internal medicine intensive care and anaesthesiology intensive care. No blood flow into the middle, anterior and posterior cerebral arteries and no activity in the venous sinuses were accepted as showing the brain death.

22 of 24 patients were reported that findings in brain scan were consistent with brain death as in the prediagnosis. Brain death was not reported in two patients with Tc-99m HMPAO scan and brain death was suspicious in one patient with Tc-99m DTPA scan. Two patients with Tc-99m HMPAO scan were died two weeks after the brain scan and the patient with Tc-99m DTPA was died one day after the brain scan.

Brain scintigraphy is a non-invasive procedure supporting the clinical diagnosis and it can be also easily performed and can exclude the negative and suspicious patients.

Key words: Brain death, the brain scintigraphy

1. Introduction

Brain death is the irreversible termination of all brain functions including brain stem functions. Intracranial blood flow has stopped physiopathologically. Diagnosis of brain death has become very important for the determination of transplantation donors. Coma, absence of brain stem reflexes, and apnea should be determined for the clinical diagnosis of brain death (1-3).

Clinical signs of brain death should be observed for 6-24 hours (4). Shock, electrolyte disturbances, metabolic disorders, drug intoxication and hypothermia that can mimic the brain death should be excluded and verification tests should be done for confirmation of brain death (4,5).

Verification tests can be used to shorten the observation time for the vitality of the organ that will be transplanted in the patients with suspicious brain death. (6). Most of the verification tests depends on the measurement of brain electrical activity and cerebral blood flow. The most commonly used verification tests are angiography, Digital-Subtraction Angiography (DSA), Contrast Enhanced Computerized Tomography (CECT), Transcranial Doppler Ultrasonography, Somatosensory Evoked

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Potentials, Electroencephalography (EEG), Brain Scintigraphy, Diffusion-Weighted Magnetic Resonance imaging (DW MRI) (7). Brain scintigraphy is used commonly nowadays because of being non-invasive, cost-effective and it is easy to be performed. In this study, we aimed to investigate the concordance of the clinic diagnosis and the results of brain scintigraphy in the patients that were referred to our clinic with the prediagnosis of brain death between the years of 2006 and 2011.

2. Material methods

24 patients with the prediagnosis of brain death that were referred to our clinic were evaluated retrospectively after the determination of coma etiology and clinical examination of brain death. Brain scintigraphy was obtained with using technetium-99m (Tc-99m) HMPAO (hexamethylpropyleneamine oxime) (Ceretek) or Tc-99m DTPA (Diethylentriamene pentaacetate) to support the clinical diagnosis of brain death.

One-second dynamic images during 60 seconds in 128x128 matrix were obtained after intravenous injection of 20 mCi Tc 99m DTPA or 10 mCi Tc 99m HMPAO with double-headed gamma camera (Forte Philips and GE600X R / T General Electrics). 5-minute anterior, posterior, right and left lateral static images were obtained in 256x256 matrix following the dynamic images. The lack of blood flow in cerebrum (supratentorial) and cerebellum (infratentorial) and the lack of blood flow to the venous sinuses are evaluated as the criterias of the diagnosis of brain death (empty skull). All of the brain scintigraphies were evaluated by two nuclear medicine experts in the department of nuclear medicine in Dokuz Eylül University, School of Medicine.

3. Results

24 patients (13 male, 11 female) were evaluated. 3 of 24 patients were under the age of 18, and 21 of 24 patients were adults. The age range of the cases was 8-76 and the average was 49.5. Brain scans were obtained with Tc-99m DTPA in 14 patients and Tc-99m HMPAO in 10 patients. Brain death as clinical prediagnosis was consistent with the results of brain scintigraphy in 22 of 24 patients (Figure 1). While scintigraphic findings in two cases with Tc-99m HMPAO did not support brain death, scintigraphic findings were suspicious and in one case with Tc-99m DTPA due to mildly visualization of the venous system (Figure 2). While two patients with Tc-99m HMPAO who had no signs of brain death in

brain scintigraphy were died 15 days after brain scintigraphy, one patient with Tc-99m DTPA who had suspicious findings for brain death in brain scintigraphy was died 24 hours after brain scintigraphy.

4. Discussion

Additional confirmation tests are necessary in the patients that brain death can not be verified clinically or suspicious cases for brain death. It has been known that the most accurate tests for the brain death are the tests showing the intracranial blood circulation. Brain scan is non-invasive, easily accessible, reproducible, inexpensive and safely usable imaging modality in order to confirm brain death. The disadvantage of the brain scan is giving no anatomical details (5, 8, 9).

EEG shows the cortical activity, but it is insufficient to show the subcortical activity in brain stem and thalamus. EEG may be false positive in the patients with barbiturate intoxication and deep anesthesia. Occasionally, residual EEG waves were detected in some of the patients diagnosed with brain death (false negative). However, these cases can be recovered with the appropriate treatments. Therefore, clinician should pay attention to the brain death while using EEG in the diagnosis of brain death (4, 10-13).

Brain scintigraphy is not affected by drug intoxication and hypothermia (4). Auditory Brain stem Response (ABR) is a kind of test that evaluates the brain stem. While brain scan is showing the cerebrum function, ABR evaluates the functions of the brain stem (14) and they complete each other. Evoked potentials are not able to evaluate all structures of the brain. They detect deep brain potentials and they can be false positive in brain traumas (15-17).

Conventional angiography may lead to false negative results because of the artifacts. Intracranial pressure increases as a result of edema, necrosis and otolysis of brain in brain death and these changes can be viewed in CT or MR. Brain death can be considered with clinical findings when no contrast increasing is observed in the intracranial cerebral vessels with CT (4,7,18).

The absence of intracranial blood flow ensured the diagnosis of brain death. If there is no blood flow into brain, brain death occurs definitely. If the patient has hypotension, the blood flow into the brain can alter and the reliability of scintigraphy decreases. The quality control of radiopharmaceuticals should be done. Lower

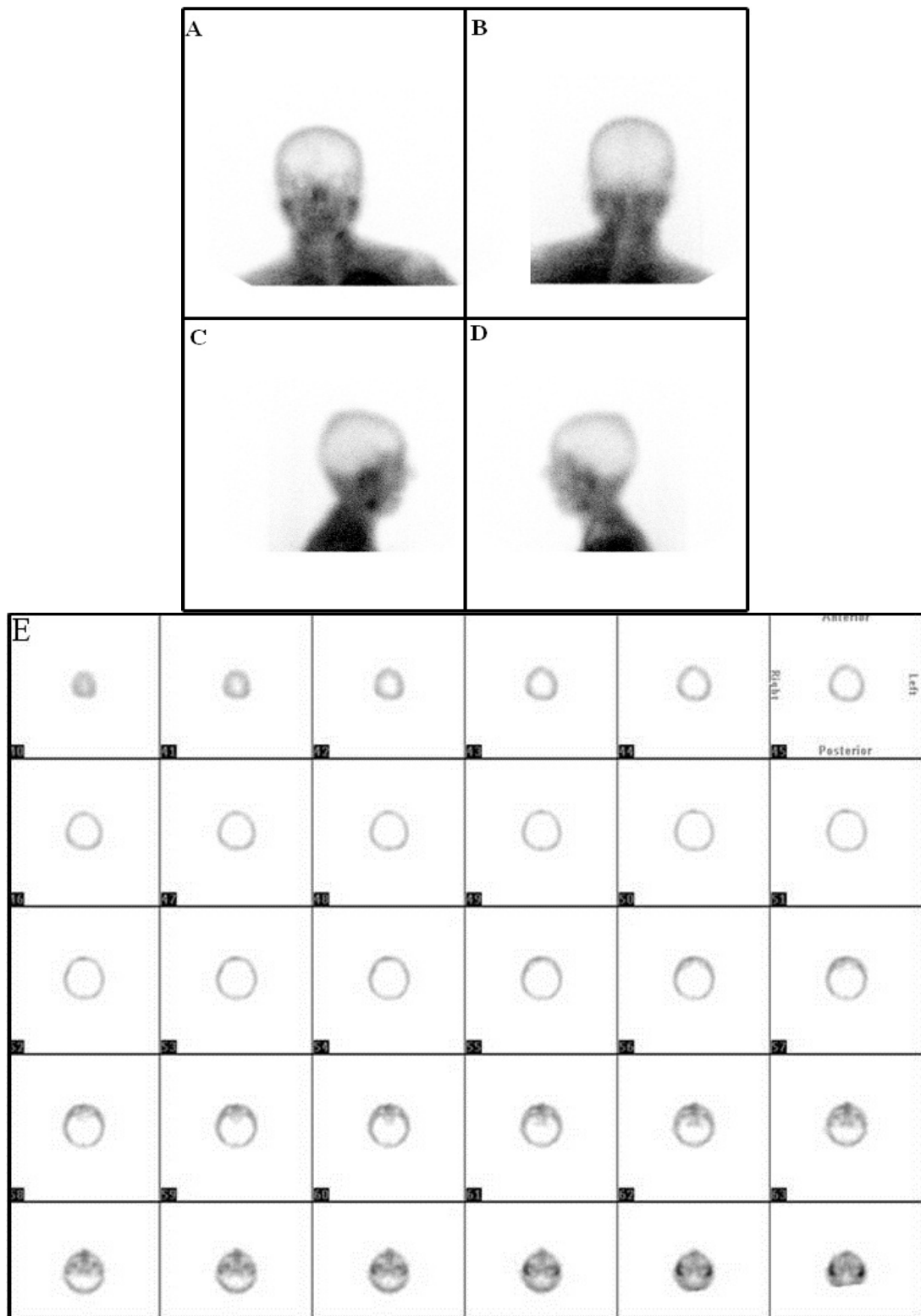


Fig. 1. Anterior (a) and posterior (b), right lateral (c) and left lateral (d) static images with Tc-99m HMPAO in a 45 year old female patient. She had cardiac arrest due to meningitis and pneumonia. No perfusion was seen in the static images (empty skull). Additionally, there was also no perfusion in dynamic images (e) of the patient.

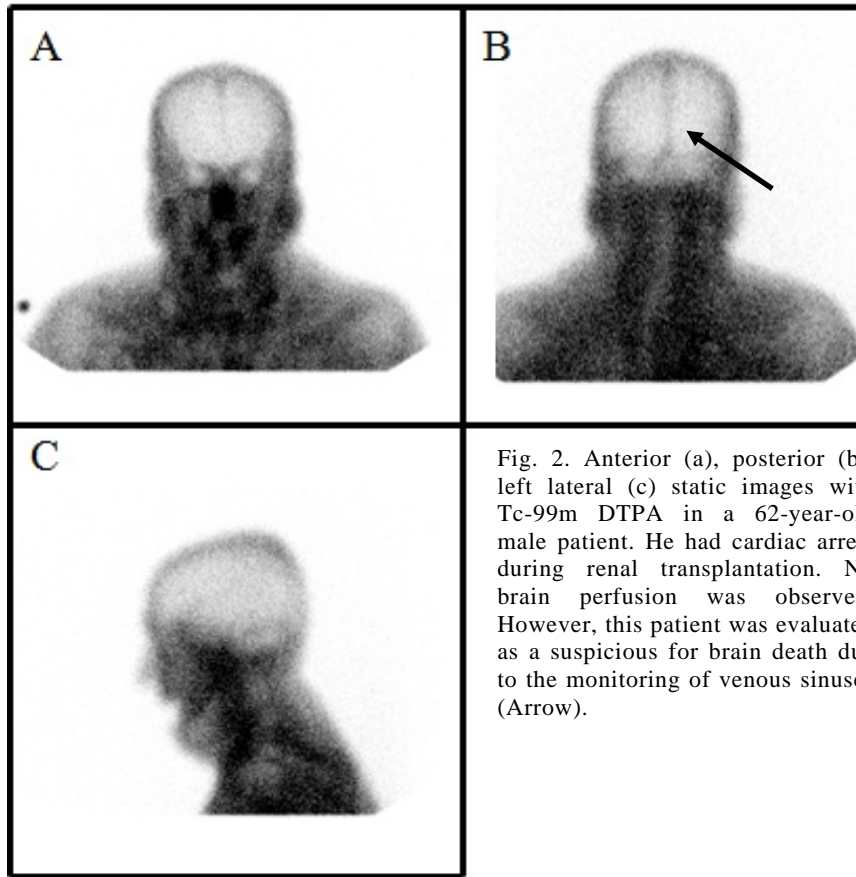


Fig. 2. Anterior (a), posterior (b), left lateral (c) static images with Tc-99m DTPA in a 62-year-old male patient. He had cardiac arrest during renal transplantation. No brain perfusion was observed. However, this patient was evaluated as a suspicious for brain death due to the monitoring of venous sinuses (Arrow).

labeling efficiency, stability problems, or remaining of the tracer in the injection place can cause small amount of radiopharmaceutical in the brain. Thus, as a result of this, brain scintigraphy can cause false positive results. The blood drainage into the superior sagittal sinus in the scalp and the use of the wrong radiopharmaceutical cause false negative results (19).

Many radiopharmaceuticals can be used in brain scan. Brain-specific (hydrophobic) radiopharmaceuticals are Tc-99m-ECD (Ethyl Cysteinate Dimer), Tc-99m HMPAO, non-specific brain (hydrophilic) radiopharmaceuticals are Tc-99m Perchnetate (with perchlorate blockade), Tc-99m DTPA, Tc-99m Glucoheptonat (4). In our study, Tc-99m HMPAO and Tc-99m DTPA were used. Rapid clearance from the blood and being reproducible are the advantages of Tc-99m DTPA. However, optimal technique must be used and sometimes interpretation may be difficult. The interpretation of brain death in brain scan with Tc-99m-ECD and Tc-99m HMPAO is easier and they are more preferred due to being brain-specific radiopharmaceuticals. Additionally, these agents

show not only intracranial blood flow but also demonstrates the brain parenchyma activity.

5. Conclusion

Brain scintigraphy is non-invasive, easily applicable technique in the diagnosis of brain death. It supports the clinical findings of brain death and when it is correctly applied, it is a reliable imaging method with low false-positive results.

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