

Tc-99 HMPAO CEREBRAL SPECT IMAGING TO CONFIRM BRAIN DEATH IN PATIENTS
WITH COMPLEX SPINAL AUTOMATISMKOMPLEKS SPİNAL OTOMATİZMALI OLGULARDA BEYİN ÖLÜMÜNÜ TANIMLAMAK
İÇİN Tc-99 HMPAO SEREBRAL SPECT GÖRÜNTÜLEME YÖNTEMİ

Dr. Ş. Ferda KAHVECİ*, Dr. Ahmet BEKAR**, Dr. Feyzi TAMGAÇ***, Dr. Gülsen KORFALI*, Dr. Eray ALPER***

ÖZET

Amaç: Bu çalışmanın amacı, spinal otomatizması olan beyin ölümü olgularında Tc-99 HMPAO serebral SPECT görüntüleme yönteminin değerini araştırmaktır.

Gereç ve yöntem: Yaşları 1.5 - 48 yıl arasında değişen, spinal hareketleri olduğu gözlemlenen, klinik olarak beyin ölümü tanısı konmuş 15 hastaya tanıyı takiben 24-72 saat içerisinde Tc-99 HMPAO serebral SPECT incelemesi yapıldı.

Bulgular: Tüm hastalarda Tc-99 HMPAO görüntülemelerinde "boş kranium" saptandı ve SPECT çalışması ile klinik beyin ölümü kararı arasında uyumsuzluk gözlenmedi.

Sonuç: Noninvaziv serebral SPECT incelemesi, spinal otomatizması olan erişkin ve çocuk beyin ölümü olgularında tanıda değerli bir yöntemdir.

Anahtar Kelimeler: Tc-99 HMPAO serebral SPECT, beyin ölümü, spinal otomatizma.

ABSTRACT

Background: The aim of this study is to evaluate the value of Tc-99 HMPAO cerebral SPECT imaging to confirm brain death in patients with complex spinal automatism.

Methods: Fifteen patients (8 female, 7 male) aged between 1.5 - 48 years showing spinal movements within 24-72 hours after brain death were examined with Tc-99 HMPAO cerebral SPECT.

Results: All patients demonstrated empty skull on Tc-99 HMPAO images and no contradictory case was observed between standard clinical criteria and SPECT study.

Conclusion: Non-invasive brain SPECT study is valuable to diagnose and confirm brain death with spinal automatism in adults and children.

Key words: Tc-99 HMPAO SPECT, brain death, spinal automatism

INTRODUCTION

Brain death (BD) is determined through tests showing global brain destruction or irreversible cessation of cerebral and brain-stem neuronal functions(1). The first widely recognized criteria on defining BD were implemented by the Ad Hoc Committee of the Harvard Medical School on BD in 1968(2).

Assessment of BD has become increasingly important since the advent of organ transplantation. To confirm the BD, the evaluation of apnea testing, brain-stem reflexes, EEG, use of transcranial Doppler, contrast cerebral angiography, evoked potentials, contrast-enhanced CT, Xenon enhanced CT and radionuclide cerebral angiography proce-

dures are being used(3-11). Radionuclide cerebral perfusion plays an important ancillary role for the diagnosis because of its reliable, non-invasive nature(12).

Spinal automatism with its unusual movements rarely occur in BD patients. These complex movements can lead to confusion for the non-initiated personnel or the family members and may raise questions on the whole procedures and lead to cancellation of organ retrieval(3,13,14).

In this study, Technetium-99m hexamethylpropyleneamine oxide (Tc-99m HMPAO) cerebral SPECT was used to confirm the diagnosis in patients having spinal automatism after BD.

MATERIALS AND METHODS

Fifteen patients aged between 1.5 to 48 years (mean, 24.4±15.6) were taken into the study. The study included eight female and seven male patients. Table 1 shows the causes of death.

The patients fulfilled the following clinical criteria for the diagnosis of BD: coma with cerebral unresponsiveness, absence of corneal reflexes, light-fixed mydriatic pupils, absence of oculovestibular reflexes, apnea when arterial PaCO₂ was above 60 torr and ventilator was removed. The spinal movements were observed within 24-72 hours after BD in all fifteen patients. The movements were consisting of myoclonic limb movements, flexion and extension jerking movement of the upper extremities, penile erection and flexion of lower extremities. The movements lasted 5-15 seconds. No movement was observed in abdominal or facial muscles.

Tc-99m HMPAO cerebral perfusion SPECT studies were performed using a large- field- of - view single-head rotating gamma camera (Starcam 3200 XR, GE Medical Systems, Milwaukee, WI) equipped with a low energy all purpose, parallel-hole collimator. SPECT acquisition procedure started 15-20 minutes after intravenous injection of 1000-1100 MBq of Tc-99m HMPAO in adults; a minimum dose of 400 MBq was used in children (Cerotec, Amersham, UK). A 20% symmetric window centered at 140 keV was used for photon detection. A total of 64 projections were acquired over 360-degree rotation, 30 seconds per frame. Filtered back pro-

jection was used for image reconstruction after preprocessing the data using a Butterworth filter. No attenuation correction was made. Transaxial, coronal and sagittal plane images were pictured. Images were interpreted by visual analysis with consensus of two readers (F.T, E.A.).

RESULTS

All patients demonstrated empty skull on Tc-99m HMPAO images. Standart clinical criteria and SPECT studies showed good correlation with no conflicting results (Fig.1) Following this confirmation the patients were declared as BD in order to be organ donors.

Figure 1: Empty skull: No uptake of Tc-99m HMPAO in the cerebrum, cerebellum and brain-stem consistent with brain death.

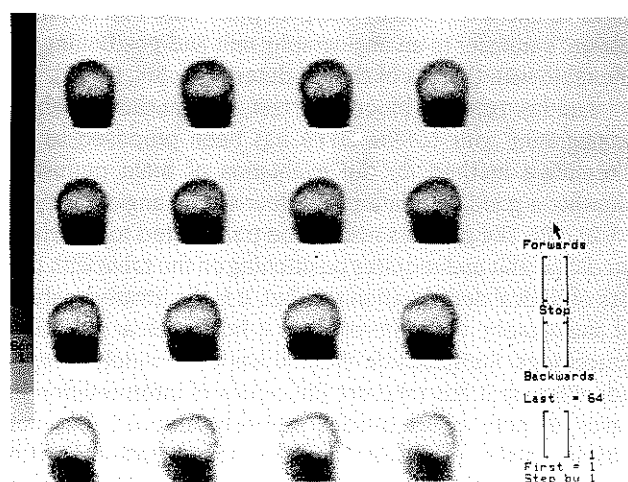


Table 1. Patients characteristics

No	Age	Sex	Cause of Brain Death	Past History
1	47	M	SAH	
2	12	F	IH	
3	34	M	IH	HT
4	25	F	SAH	PET
5	16	M	TBD	
6	1.5	F	TBD	
7	35	M	SH	
8	7	F	CO Intox	
9	22	F	IH	PET
10	24	M	TBD	
11	36	M	SH	
12	28	M	TBD	
13	22	F	IH	
14	48	F	SAH	
15	15	F	TBD	

SAH. Subarachnoid haemorrhage, IH. Intracerebral haemorrhage, TBD. Traumatic brain damage, SH. Subdural haematoma, PET. Preeclamptic toxemia, HT. Hypertension, CO Intox. Carbonmonoxide intoxication.

DISCUSSION

Patients with unusual movements, after declaration of BD, have been described previously(3, 13,14). An unequivocal early diagnosis of BD is necessary in comatose patients who may be organ donors and this involves complicated moral, ethical, medical and legal considerations(15, 16).

As seen in our patients these movements occurred spontaneously, after mechanical stimulation following neck flexion, or noxious stimulation of supraclavicular area(3). While some authors suggested that these motor manifestations reflected the partial activity in agonal spinal cord neurons, others claimed that unusual movements were likely a reflection of the physiological potential of spinal cord. The movements may have been generated by neurons in the rostral regions of spinal cord(3, 13, 16). However, spinal automatism occurs as a result of a spinal arc reflex and in no way negates the diagnosis of BD.

The diagnostic criteria rely on three factors to determine the BD: firstly, irreversibility of brain damage, secondly, absence of the corneal reflexes, light-fixed mydriatic pupils, absence of brain-stem reflexes (oculovestibular, oculocephalic reflexes), including apnea; and thirdly, electro

cerebral silence on an EEG or non filling of cerebral vessels on a four-vessel angiogram. These criteria have to be fulfilled in BD patients having no drug intoxication, hypotensive metabolite disturbances, shock, peripheral nerve and muscle dysfunction due to neuromuscular blockade or hypothermia (below 35 °C)(15, 16, 17).

The measurement of cerebral blood flow may constitute a decisive diagnostic criteria for BD(11, 18, 19). As a matter of fact, a reliable assessment of cerebral circulatory arrest is to be considered as the gold standard, since this is an important phenomenon of the whole brain. Thus, the common BD criteria for many countries is to consider, at least in particular cases, the determination of cerebral blood flow(20).

One of the cerebral blood flow tests, contrast medium angiography, has been widely used in the past, but it is an invasive and a technically complex procedure that requires patient's transfer to an angiography unit and positioning on the table with the risk of clinical deterioration(4, 21, 22).

Another cerebral blood flow test, radionuclide cerebral angiography with Tc-99m DTPA has been proposed as an alternative method for the evaluation of brain perfusion showing a good correlation with four-vessel angiography(4, 18, 21, 22). The patients need to be transported to a nuclear medicine unit and requires positioning on the table with the risk of clinical deterioration too. But, it is the invasive nature of angiography that differentiates it from nuclear medicine procedures. Radionuclide method has been widely accepted, although it has inherent difficulties of interpretation in cases of poor bolus quality, severely reduced, but not absent brain perfusion and in some patients with hematomas and trauma. In addition, radionuclide perfusion scintigraphy only assesses hemispheric brain perfusion with poor visualization of the posterior fossa and brain stem(5, 12, 23).

Tc-99m HMPAO is a neutral, lipophilic radiopharmaceutical that crosses the intact blood brain barrier and is trapped by brain tissue in proportion to regional perfusion(12, 19, 24, 25). Several reports exist about the usefulness of Tc-99m HMPAO in the diagnosis of BD(4, 18, 26, 27). Tc-99m HMPAO brain uptake has been reported in patients thought to be BD on clinical grounds and who subsequently recovered(27). The patients who did not have BD showed HMPAO uptake at least in the brain-stem(4).

In our study all patients showing empty skull were confirmed as BD by standard clinical criteria, with no contradictory cases in the SPECT study.

The advantages of Tc-99m HMPAO cerebral perfusion scintigraphy over conventional agents such as Tc-99m glucoheptonate or DTPA have been discussed in the literature. Firstly, it does not depend on the adequacy of the bolus injection to determine BD. Although these radiopharmaceuticals are adequate in the vast majority of patients, good bolus is critical and this point is more difficult to achieve in small children. Secondly, there is no complete agreement

about the significance of persisting dural venous sinus activity. These features have to be taken into consideration if flow agents are used. Thirdly, Tc-99m HMPAO allows visualization of the posterior fossa perfusion that may be present in the absence of supratentorial cerebral blood flow. In addition, the test is easier to interpret in patients with severely decreased cerebral blood flow. Finally, it displays regional blood flow in a more detailed fashion, since cortical uptake of HMPAO depends on cerebral blood flow(12, 19).

However, there are also two disadvantages of this method. Firstly, higher cost of the Tc-99m HMPAO, although it is still less expensive than the total cost of a repeat study using other flow agents. Secondly, the patients need to be transferred to a nuclear medicine unit if a portable gamma camera is not available(18, 19).

In conclusion, brain SPECT study is a valuable, non-invasive test for diagnosing and confirming BD with spinal automatism in adults and children.

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* Anesthesiology and Reanimation, University of Uludağ, School of Medicine

** Neurosurgery, University of Uludağ, School of Medicine

*** Nuclear Medicine, University of Uludağ, School of Medicine

Correspondence: Ş. Ferda Kahveci, M.D.,

Department of Anesthesiology and Reanimation University of Uludağ,

School of Medicine, Görükle, 16059, Bursa, TÜRKİYE

e-mail: ici@uludag.edu.tr