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Oscillating transcranial Doppler patterns of brain death associated with therapeutic maneuvers

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KEYWORDS
Brain death;
Transcranial Doppler (TCD);
Intracranial pressure (ICP);
Patterns;
Oscillating flow;
Spikes

Summary
Background: Transcranial Doppler (TCD) is a specific test for brain death diagnosis. Several Doppler patterns could change slightly during an increase of intracranial pressure related to mass effect.
Methods: We present two patients with a clinical diagnosis of brain death after massive brain hemorrhage. A Doppler pattern of reverse flow with small diastolic positive flow in both middle cerebral arteries and basilar arteries was observed in both cases.
Results: TCD was repeated 6 h later, showing an increase of systolic and diastolic flow associated with high intracranial pressure (ICP) in the first patient and a decrease of ICP in the second patient associated with polyuria. Transient improvements of blood cerebral flow could be related to the use of adrenergic drugs or the use of osmotic drugs to decrease ICP. Finally the patients showed a pattern of low spikes that led to the diagnosis of cerebrovascular arrest and brain death.
Conclusions: Therapeutics drugs to decrease ICP and several physiological processes can change several patterns of TCD associated with progression of brain death.

Background

Transcranial Doppler (TCD) is a sensitive and specific test for brain death diagnosis [1].

Cerebral circulatory arrest is initially associated with Doppler evidence of oscillatory movement of blood in the large arteries at the base of the brain, but net flow is zero. This is mainly due to the elasticity of the arterial wall and the compliance of the vasculature distal to the recording site. This first pattern, diagnostic of brain death, has been validated with angiographic vascular arrest in the literature [2,3]. These oscillations eventually become low amplitude spectral spikes and finally no pulsations are detectable. In vivo experiments show that around 10—15 min of total cerebral ischemia lead to irreversible total loss of cerebral function. Therefore, a short time of cerebral circulatory arrest demonstrated by ultrasounds is sufficient to confirm irreversibility and hence cerebral death [4,5].

Several Doppler patterns could change slightly during an increase of intracranial pressure related to mass effect. We

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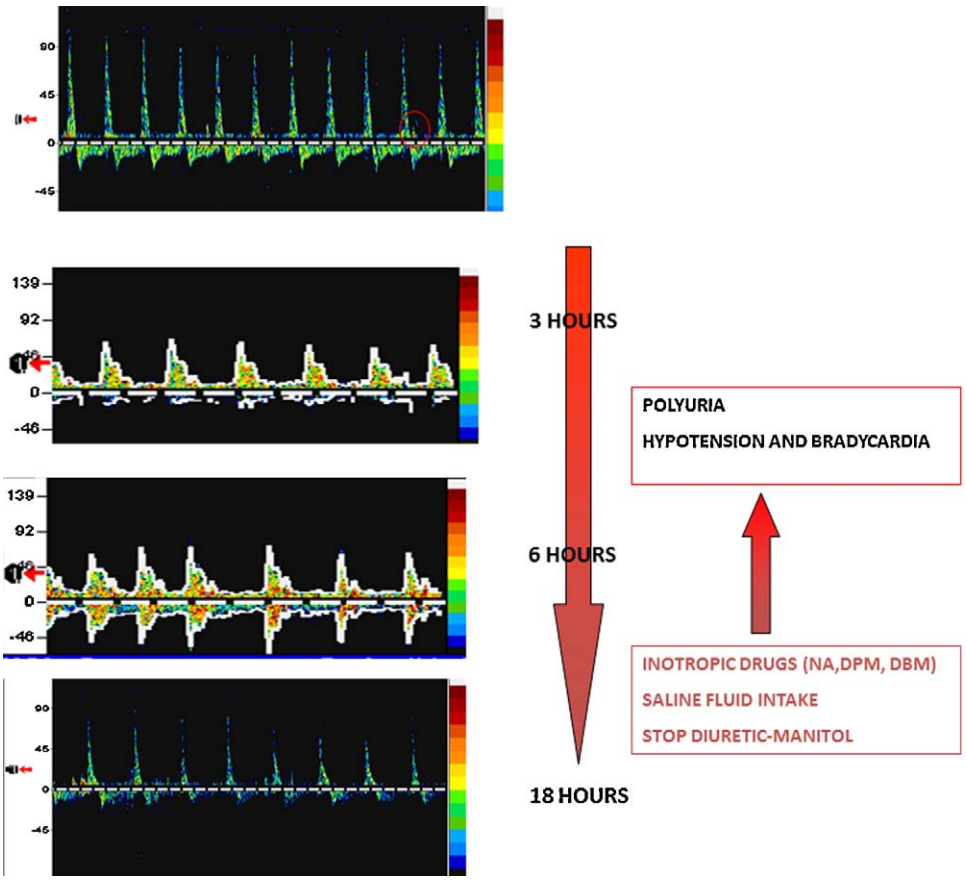

Figure 1 TCD showing reverberating flow (top image), but with brief diastolic positive spikes, that was incompatible with brain death. After a few hours TCD showed improvement of diastolic flow with a high and positive pattern possibly related to the polyuric phase and use of inotropic drugs. The last Doppler image shows isolated brief systolic flow with spikes. At that moment the patient was diagnosed of brain death.

present two patients with severe changes in Doppler patterns during evaluation of brain death.

Methods and Results

We present two patients with a clinical diagnosis of brain death but with positive blood benzodiazepine levels.

Both suffered a hemorrhagic stroke consisting of lobar hematoma and massive subarachnoid hemorrhage, with an initial exam of coma in the emergency room (GCS 3—5), and they underwent oral intubation. TCD (DWL-Multidop 2 MHz probe) was performed 24 h after hospital admission.

A Doppler pattern of reverse flow with small diastolic positive flow in both middle cerebral arteries and basilar arteries was observed in both cases. The patients were maintained with respiratory support in an intensive care unit. TCD was repeated 6 h later, showing an increase of systolic and diastolic flow associated with high intracranial pressure (ICP) in the first patient and a decrease of ICP in the second patient associated with polyuria. A new TCD examination 6 h later finally showed a pattern of low spikes that led to the diagnosis of cerebrovascular arrest and brain death.

Discussion

Extensive death of hemispheric tissue, intracranial bleeding or brain swelling can cause severe increase of ICP. If the ICP equals the diastolic arterial pressure, the brain is perfused only in systole and if ICP rises over the systolic arterial pressure, cerebral perfusion will cease [2]. Oscillating flow or systolic spikes are typical Doppler-sonographic flow signals found in the presence of cerebral circulatory arrest, which if irreversible, results in brain death. This first diagnostic pattern of brain death has been validated with angiography in the literature.

Transient improvements of blood cerebral flow could be related to the use of adrenergic drugs or the use of osmotic drugs to decrease ICP.

The use of adrenergic drugs is very common to treat hypotension associated with brain herniation and failure of the autonomic nervous system. The use of osmotic drugs is mandatory to improve intracranial pressure but is not