

# A rare spinal reflex in brain death: Bilateral plantar flexion in nuchal rigidity examination

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## Abstract

A 74-year-old female patient, who developed a hypoxic brain injury after cardiopulmonary arrest, was diagnosed with brain death on the 4th day of the clinical onset depending on the absence of brainstem reflexes and the intracranial blood circulation in magnetic resonance angiography, and positive apnea test. Bilateral plantar flexion response to the neck flexion was observed while lifting the head for the examination of oculocephalic reflex during the in-service nurse training. The plantar flexion response was observed every time the neck flexion was performed. This finding was interpreted primarily in favor of spinal reflex and the repeated brain death tests confirmed the diagnosis. Regarding the literature, spinal reflexes may emerge in patients with brain death and plantar flexion is among the most common reflexes. These reflexes are usually observed following painful stimuli, during the apnea test or when the patient is taken off the mechanical ventilation. Although the nuchal rigidity examination is not included in the routine diagnosis procedure of brain death, in this paper we report bilateral plantar flexion as a response to the neck flexion in a patient with brain death in the light of the studies found in the literature. We conclude that the introduction of the above-mentioned examination to the diagnosis of brain death will contribute to the improvement of the diagnosis procedure and prevent delays in the preparation of the potential donors.

**Keywords:** Brain death, spinal reflex, apnea test, magnetic resonance angiography

## INTRODUCTION

Spontaneous and reflexive movements originating from the spinal cord, which should not prevent the diagnosis of brain death, can be observed in patients with brain death. Various types of spinal reflexes ranging from the most dramatic Lazarus sign to simple muscle movements are described in the literature.<sup>1</sup> In this case report, we presented the bilateral plantar flexion response during the nuchal rigidity examination, which was observed in a patient with brain death.

## CASE REPORT

A 74-year-old female patient developed cardiac arrest after the sudden onset of respiratory failure due to a mass in the right lung while she was under follow-up in the hospital for investigation. The patient responded to cardiopulmonary resuscitation, which was implemented for approximately 25 minutes. No additional pathological findings were observed

except for elevated cardiac enzymes. Following the resuscitation, the unconscious and intubated patient was referred to the intensive care unit (ICU) with a Glasgow Coma Score (GCS) of 3. The patient's body temperature was decreased to 33-34°C. No sedoanalgesia was applied to the patient. She received noradrenaline (at the highest dose of 0.2 mcg/kg/min) during this follow-up period. No additional pathology was detected in the urine or blood gas tests. During the examination on the 4th day of the follow-up, body temperature was normal, no signs of fluid-electrolyte imbalance were observed. However, the patient did not respond to intubate aspiration. Following the absence of the brainstem reflexes during the examination, an apnea test was performed, and no respiratory response was observed to the increased carbon dioxide levels. In the cerebral magnetic resonance angiography (MRA), no blood flow was noticed in the intracranial arteries, and imaging consistent with brain death was reported (Figure 1). Bilateral

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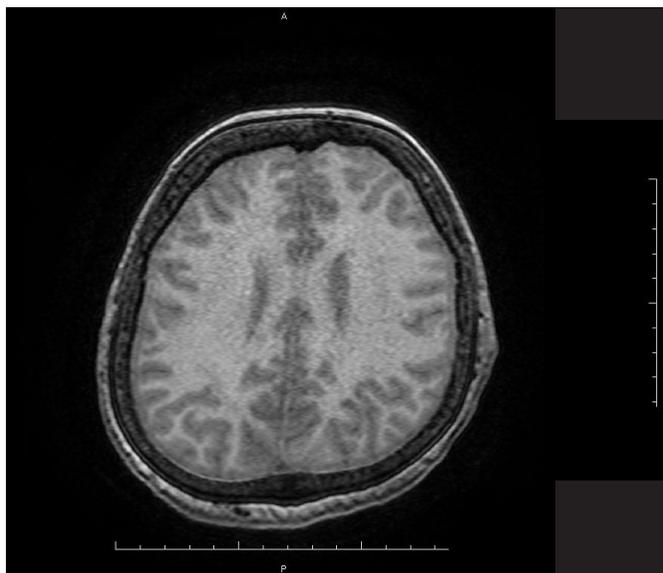


Figure 1. Images obtained during MR angiography showing absence of blood flow in the intracranial arteries.

plantar flexion response to the neck flexion was observed incidentally during the training of the intensive care nurses on the implementation of the oculoccephalic reflex examination. The plantar flexion response was observed every time the neck flexion was repeated for the nuchal rigidity examination. (Video 1) No response was observed to the painful stimulus applied to the patient's forehead, fingernails, toenails, legs, and trunk. Diagnosis of brain death was confirmed with the re-examination of the brain stem reflexes and apnea test. The plantar flexion in response to the nuchal rigidity examination (neck flexion) was interpreted in favor of spinal reflex.

## DISCUSSION

Brain death is a clinical diagnosis made in a coma patient depending on the absence of brain stem reflexes, respiratory response to increased carbon dioxide levels in the blood (apnea test), and the lack of the cerebral blood flow or electrical activity in supportive tests. In principle, in patients diagnosed with brain death, no response should be observed to painful stimuli applied to any part of the body, such as reflex automatism of the facial musculature.<sup>2</sup> In patients with brain death, spontaneous or post-stimulus plantar responses originating from the spinal cord, muscle stretch reflexes, abdominal reflexes, finger movements, and reflex responses, such as the most dramatic Lazarus sign, may be observed and they do not preclude the diagnosis of brain death.<sup>1</sup> We

believe that the awareness and good knowledge about these reflexes will eliminate the confusion that may arise in minds of healthcare personnel and patient relatives, and will prevent delays in diagnosis of brain death.

In a prospective study conducted by Döşemeci *et al.*, the authors screened spinal reflexes in 134 patients with brain death and observed spinal reflexes in 18 of these patients. The Lazarus sign was observed in 2 of these patients; flexion of arms and abduction in shoulders in 3 patients; concussion in the fingers and toes in 8 patients, and arm-shoulder extension and arm and foot flexion in the remaining 5 patients.<sup>1</sup> Kim *et al.* investigated 436 patients diagnosed with brain death and detected reflexes or spontaneous movements in 74 of these patients. They reported that the most common reflex was the plantar extension and flexion response to painful stimuli, which were observed in 30 of the participating patients.<sup>3</sup> Beckman *et al.* evaluated 144 patients diagnosed with brain death and showed that 32 patients, in whom toe fluctuations, increased deep tendon reflexes, Lazarus sign, arm-neck flexion, fasciculations, and finger twitches were observed, had spontaneous and spinal reflexive movements.<sup>4</sup> In a study conducted by Conci *et al.*, viscerovisceral and viscerosomatic reflexes were investigated and the authors observed a contraction response in the abdominal muscles during the peritoneal incision in 15 of the 25 patients, who underwent laparotomy for donor nephrectomy. A cardiovascular reflex response

to the peritoneal incision was observed in 6 patients and inotropic and vasoactive agents were required.<sup>5</sup>

In a case report, Khan *et al.* applied a painful stimulus to the nail bed of the fourth hand finger of the patient diagnosed with brain death and observed a reflex response similar to the “Hoffman reflex”, a finger flexion seen in upper motor neuron injuries.<sup>6</sup> In their case report video prepared for educational purposes, Zheng *et al.* demonstrated similar hand-finger flexion movements in their patients diagnosed with brain death.<sup>7</sup> In their case report, Hernandez *et al.* observed a plantar flexion response following a painful stimulus applied to the toes of a patient with brain death.<sup>8</sup>

Regarding the diagnosis of brain death, the routine examination procedure does not ask for a nuchal rigidity examination. We observed bilateral plantar flexion response every time the neck flexion movement was performed for the nuchal rigidity examination. We confirmed the diagnosis of brain death with the help of the apnea test and MRA as a supportive test. We did not encounter any paper in the literature describing a similar reflex movement. We present this case report to increase the awareness about the spinal reflexes in brain death, and thus to eliminate any question marks arising in minds of the intensive care staff and to avoid waste of time in the preparation of the potential donors. The written informed consent had been obtained from the patient’s relative.

**Video 1:** Video showing that upon flexion of the neck, there is reflex bilateral plantar flexion. [https://neurology-asia.org/content/28/1/neuroasia-2023-28\(1\)-233-v1.mp4](https://neurology-asia.org/content/28/1/neuroasia-2023-28(1)-233-v1.mp4)

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