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JAHI McMATH: A NEW STATE OF DISORDER OF CONSCIOUSNESS

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   Description: 2A: This figure shows 65 seconds of EEG recorded from 19 standard channel leads, contaminated with ECG. A disorganized EEG background, with a prevalence of diffuse Delta-theta activity is found. Although records were characterised by a a low-votage output, EEG amplitude was clearly over 2 μV, excluding a pattern of electro-cerebral inactivity. 2B: The figure 3 shows the power spectra density obtained for 65 seconds of free of artefacts continuous EEG. EEG activity is mainly in the delta-theta range. In the Fp2 and Fz leads there is an incipient, but observable, peak in the alpha band. In the O1 lead, a visible Delta peak is also present. Several power spectra density inter-hemispheric asymmetries are found for homologous EEG leads.
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4. Figures 6
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   Description: 3A: The power spectral density for the whole HRV spectrum is present. Discrete spectral frequencies within the VLF, LF, MF, and HF bands are clearly present, in spite of low power spectral density. 3B: The instantaneous spectral amplitudes of the respective IMFs are presented. Tacogram is shown in the first diagram. A thick blue vertical line indicates the beginning of the “Mother Talks” stimulus, compared with the “Basal Record.” It is possible to observe ostensible dynamics in the different HRV frequencies, indicating a manifest autonomic reactivity to the mother’s voice stimulus
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JOURNAL OF NEUROSURGICAL SCIENCES

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Sincerely,

Calixto Machado, MD, PhD

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JAHI McMATH: A NEW STATE OF DISORDER OF CONSCIOUSNESS

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Brain death has been progressively accepted in the last decades, but contentious braindead cases have raised up new disputes on the determination BD, such as the Jahi McMath case.[1-3]

Case Report

Jahi McMath suffered a massive bleeding as a surgical complication leading to a cardiorespiratory arrest. She was declared brain-dead on December 12, 2013. Her parents did not accept this diagnosis, and after an unusual lawful treaty she was moved to the New Jersey State. The patient finally died on June 22, 2018.[2, 3]

The author, Dr. Calixto Machado, a Cuban neurologist was requested as an expert consultant in September 2014. She was studied at the Rutgers Hospital where an US licensed neurologist, assessed her clinically and prescribed a group of ancillary tests suggested by Dr. Machado.

This manuscript was approved by the Havana Institute of Neurology and Neurosurgery Ethics Committee, according to the Helsinki Declaration. The Author received Informed consent from Jahi McMath's mother to publish this material.

Jahi McMath's findings after 9 months of her initial diagnosis[1, 3]

- Clinical examination. Absent brainstem reflexes, not even triggering the ventilator. Apnea test was not performed at this time, because Jahi McMath's relatives did not give consent.
- MRI demonstrated conservation of intracranial structures, despite the existence of vast abnormalities. A huge lesion was found in pons. MRI demonstrated preservation of tracts connecting the brainstem with thalamus and cerebral cortex, and tracts were also present in the cerebral hemispheres linking several cortical areas.
- EEG activity over 2 μV of amplitude. The power spectra density showed that EEG activity was mainly in the delta-theta range.
- Heart rate variability (HRV) bands were well-preserved.
- Autonomic reactivity, measured by HRV, to the "Mother Talks" stimulus demonstrated autonomic function reactivity.

Discussion

Although the patient fulfilled clinical BD criteria, the preservation of intracranial structures (including the present or tracts connecting the brainstem with upper regions, and linking several cortical areas), EEG over 2 μV, conservation of HRV components, and

autonomic reactivity response to the "Mother Talks" stimulus, demonstrated remaining brain function in both brainstem and cerebral hemispheres, rejecting that she was braindead.[1]

A complete arrest of cerebral blood flow (CBF) is a condition sine qua non for the concept of BD. Neurons are permanently injured after a few minutes of complete CBF ending. Hence, conservation of intracranial structures is a strong evidence of residual CBF.[1, 3, 4]

The use of ancillary tests in BD determination is related to the definition of death on neurological grounds: whole brain, brainstem death and higher brain standards.[4]

When intracranial pathology is localized to the posterior fossa, both CBF and EEG may persist, because these lesions don't produce noticeably raised intracranial pressure. Therefore, several countries from continental Europe, Central and South America, and Asia, require the demonstration of an EEG showing electrocerebral silence for the certification of BD.[3]

BD has been characterized by the loss of all HRV power. On the contrary, all HRV bands. BD were preserved in this patient, demonstrating preservation of autonomic function. Moreover, autonomic reactivity to "Mother Talks" stimulation demonstrated remaining function at different levels of the central autonomic system.[3] These results support Dr. Shewmon's analysis of Jahi McMath's videos, who emphasized that her movements reflected responses to her mother.[1, 3, 5]

Jahi McMath was not comatose because although she was clinically in a sleep-like state of unarousable and unresponsiveness, without evidence of awareness of self or environment, a full absence of brainstem reflexes, rejected the possibility to be in coma. In this case the possibility of drug intoxication was excluded, which could explain the nonappearance of brainstem reflexes. Some comatose patients show favorable outcome, but persist unaware of self or environment, firstly named vegetative state (VS), and more recently, "unresponsive wakefulness syndrome" (UWS). Therefore, Jahi McMth was not a UWS, because she was not in a wakefulness state, and showed partial responsiveness. Moreover, UWS patients fully or partially retain brainstem reflexes, and usually breathe by their own. It is not possible to classify Jahi McMath as a locked-in syndrome (LIS), because she was not in a wakefulness state, and showed partial responsiveness. Furthermore, LIS patients, although quadriplegic, usually preserve fully or partially brainstem reflexes, vertical eye movements, and/or blinking, and don't require mechanical ventilation. The "minimally conscious state" (MCS) is a higher state in the continuum of consciousness, showing inconsistent but reproducible evidence of awareness of self or environment. (MCS). Jahi McMath was not a MCS, because she was in a sleep-like condition without preservation of arousal. Another critical difference is that MCS

has been always defined as a intermediate state between coma, UWS, and higher level of consciousness, but a MCS has never been described in a patient fulfilling all clinical BD criteria.[3]

The relative intactness of the upper brainstem, thalamus and cortex as well as the partial sparing of the mesopontine tegmental reticular formation might explain the intermittent conscious responses in this patient. Her connections to the thalamo-cortical and/or its ventral pathway to the cortico-cortical projection systems, and parts of the associative cerebral cortices, were surely preserved. [1, 3]

Conclusion

Jahi McMath was a rare and argumentative case. The concept of BD is not denied with the discussion of this case, but brings back the debate of using or not ancillary tests in BD confirmation. [1]

I concluded that Jahi was in new state of disorder of consciousness, non-previously described, that I have termed: "responsive unawake syndrome" (RUS).

REFERENCES

1. Machado C, Estevez M, DeFina PA, Leisman G. Response to Lewis A: Reconciling the Case of Jahi Mcmath. Neurocrit Care 2018;29:521-522.
2. Truog RD. Lessons from the Case of Jahi McMath. Hastings Cent Rep 2018;48 Suppl 4:S70-S73.
3. Machado CD, P.A.; Estevez, M.; Leisman, G.; Rodriguez, R.; Presitigiacomo, C.; Fellus, J.; Halper, J.; Chinchilla, M.; Aubert, E.; Machado, Y.; Machado, Y. A Reason for care in the clinical evaluation of function on the spectrum of consciousness Journal Functional Neurology, Rehabilitation and Ergonomics and Rehabilitation 2017;4:542-556.
4. Bernat JL, Dalle Ave AL. Aligning the Criterion and Tests for Brain Death. Camb Q Healthc Ethics 2019;28:635-641.
5. Shewmon DA. Truly Reconciling the Case of Jahi McMath. Neurocrit Care 2018;29:165-170.

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TITLES OF FIGURES

Figure 1

1A: MRI – T1 sagittal left view is presented. MRI shows preservation of intracranial structures, in spite of the presence of vast abnormalities: remarkable preservation of cortical and brainstem gross anatomy, with non-expected relative slight atrophy, in spite of cortical laminar necrosis, demyelination, and cystic encephalomalacia in the centrum semiovale, corpus callosum, and posterior pons and medulla. MRI in also shows a huge lesion in the posterior regions of the pons, lateralized to the left side (arrow).

1B: MRI Tractography placed over a MRI frontal view, shows tracts connecting the brainstem with thalamic and cortical regions. Fewer tracts are found for left areas of the brainstem.

1C: MRI Tractography placed over a MRI sagittal view shows tracts connecting several cortical areas. Fewer tracts are found for left brain hermisphere.

Figure 2.

2A: This figure shows 65 seconds of EEG recorded from 19 standard channel leads, contaminated with ECG. A disorganized EEG background, with a prevalence of diffuse Delta-theta activity is found. Although records were characterised by a a low-votage output, EEG amplitude was clearly over 2 μV, excluding a pattern of electro-cerebral inactivity.

2B: The figure 3 shows the power spectra density obtained for 65 seconds of free of artefacts continuous EEG. EEG activity is mainly in the delta-theta

range. In the Fp2 and Fz leads there is an incipient, but observable, peak in the alpha band. In the O1 lead, a visible Delta peak is also present. Several power spectra density inter-hemispheric asymmetries are found for homologous EEG leads.

Figure 3.

3A: The power spectral density for the whole HRV spectrum is present. Discrete spectral frequencies within the very low frequency (VLF), low frequency (LF), middle frequency (MF), hight frquency (HF), adn very high frequency bands (VHF) are clearly present, in spite of low power spectral density.

3B: The instantaneous spectral amplitudes of the respective IMFs are presented. Tacogram is shown in the first diagram. A thick blue vertical line indicates the beginning of the "Mother Talks" stimulus, compared with the "Basal Record." It is possible to observe ostensible dynamics in the different HRV frequencies, indicating a manifest autonomic reactivity to the mother's voice stimulus.