International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Detection of Brain Death in Barbiturate-Induced Coma: The Dilemma of an Intracranial Pulse

Dr. Sheikh Khurshid Alam Ali[1], Dr. Kalyan Sarma[2]

[1]Consultant, Department of Neurosurgery, The Tamil Nadu Multispeciality Hospital, Chennai, Tamil Nadu, India

[2]Associate Professor, Department of Anaesthesiology and Critical Care, Nagaon Medical College, Nagaon, Assam, India

Abstract: ***Introduction: Diagnosing brain death in barbiturate coma is tricky due to suppressed activity and persistent pulse signals. This study tests TCD reliability in eight TBI patients, finding 50% mismatch with clinical criteria, urging protocol revision. Methods: Eight TBI patients (18–65) in barbiturate coma (pentobarbital, 20–40 µg/mL, ≥48h) were studied (2024–2025). Brain death assessed via AAN guidelines and TCD (2-MHz, MCA flow). Exclusions: instability, incomplete data. Descriptive stats used. Results: All eight (5 male, mean age 42.3) met clinical brain death criteria. TCD showed pulsatile flow in 50%, others had brain death patterns (reverberating, n=3; absent, n=1). Two recovered, two confirmed dead post-weaning. Discussion: 50% TCD-clinical mismatch shows barbiturates mimic brain death, with pulsatile flow hinting at perfusion. Recovery risks premature calls; weaning clarifies. Multimodal testing needed. Conclusion: Barbiturates skew brain death diagnosis, with 50% TCD discordance. Revised guidelines with clearance or combined tests are key, pending bigger studies.***

Keywords: Brain death, barbiturate coma, TCD, TBI, pulse, neurocare

1. Introduction

Brain death, defined as the irreversible cessation of all brain functions, including the brainstem, is a critical diagnosis in intensive care settings, often required for decisions regarding organ donation or withdrawal of life support [1]. Standard clinical criteria, such as the absence of brainstem reflexes, apnea, and unresponsiveness, are well-established [2]. However, in patients under barbiturate-induced coma—commonly used to manage refractory intracranial hypertension following TBI—these criteria become unreliable due to the drug's profound suppression of neurological activity [3]. Barbiturates, such as pentobarbital, reduce cerebral metabolism and blood flow, mimicking brain death-like states, yet residual intracranial pulse signals detected by TCD can persist, complicating diagnosis [4].

This study aims to evaluate the efficacy of TCD as an ancillary test for confirming brain death in barbiturate-treated patients, focusing on the persistence of intracranial pulse and its implications. With a sample size of eight patients, we explore whether current diagnostic tools adequately differentiate between drug-induced suppression and true brain death, addressing a critical gap in neurocritical care.

2. Methods

This prospective observational study was conducted at a tertiary neurocritical care unit between January 2024 and March 2025. Eight adult patients (aged 18–65 years) with severe TBI requiring barbiturate-induced coma for intracranial pressure (ICP) management were enrolled. Inclusion criteria included: (1) pentobarbital infusion for at least 48 hours, (2) stable therapeutic serum levels (20–40 µg/mL), and (3) clinical suspicion of brain death based on initial neurological assessment. Exclusion criteria included hemodynamic instability or incomplete medical records.

Brain death assessment followed the American Academy of Neurology (AAN) guidelines [2], including clinical examination (coma, absent brainstem reflexes, apnea test) and ancillary testing with TCD. TCD was performed using a 2-MHz probe to evaluate middle cerebral artery (MCA) flow patterns, with brain death confirmed by reverberating flow or absent diastolic flow [5]. Barbiturate levels were monitored via serum assays, and ICP was measured using intraparenchymal monitors. Data were collected on clinical findings, TCD results, and patient outcomes (brain death confirmation or recovery). Descriptive statistics were used due to the small sample size.

3. Results

Of the eight patients (5 male, 3 female; mean age 42.3 ± 12.7 years), all exhibited clinical signs consistent with brain death: unresponsiveness, absent brainstem reflexes, and positive apnea tests when feasible (n=6; two patients were hemodynamically unstable for apnea testing). Pentobarbital levels ranged from 22 to 38 µg/mL, confirming therapeutic coma. ICP values were elevated (>20 mmHg) in all cases prior to coma induction but normalized (<15 mmHg) during barbiturate therapy.

TCD findings revealed a discrepancy in four patients (50%). In these cases, despite meeting clinical brain death criteria, TCD demonstrated persistent low-velocity pulsatile flow in the MCA, inconsistent with the expected reverberating or absent flow patterns of brain death [5]. In the remaining four patients, TCD confirmed brain death with classic findings (reverberating flow, n=3; absent flow, n=1). Among the discrepant cases, two patients were later declared brain dead after barbiturate weaning (confirmed by repeat TCD and EEG), while two showed neurological recovery after extended observation (Table 1).

Table 1: Summary of Patient Outcomes

Patient	Clinical Brain Death	TCD Finding	Outcome
1	Yes	Reverberating Flow	Brain Death Confirmed
2	Yes	Pulsatile Flow	Recovery
3	Yes	Absent Flow	Brain Death Confirmed
4	Yes	Pulsatile Flow	Brain Death (Post-Weaning)
5	Yes	Reverberating Flow	Brain Death Confirmed
6	Yes	Pulsatile Flow	Recovery
7	Yes	Pulsatile Flow	Brain Death (Post-Weaning)
8	Yes	Reverberating Flow	Brain Death Confirmed

4. Discussion

The detection of brain death in barbiturate-induced coma remains a diagnostic conundrum, as evidenced by the 50% discrepancy rate between clinical criteria and TCD findings in this study. Barbiturates reduce cerebral metabolic rate and blood flow, potentially mimicking brain death, yet the persistence of intracranial pulse signals suggests residual cerebral perfusion [3, 4]. This phenomenon may reflect barbiturate-mediated vasoconstriction rather than viable brain function, complicating TCD interpretation [6].

In our cohort, the four patients with pulsatile TCD flow highlight the limitations of relying solely on ancillary tests without considering drug pharmacokinetics. The two patients who recovered underscore the risk of premature brain death declaration, while the two confirmed post-weaning suggest that barbiturate clearance may unmask true brain death. These findings align with prior reports of false-positive TCD results in barbiturate-treated patients [7], emphasizing the need for serial testing or adjunctive modalities like EEG or cerebral angiography, though these too have limitations in this context [8].

The small sample size (n=8) limits generalizability, and the absence of a control group precludes definitive conclusions. Nonetheless, this study raises critical questions about the validity of current brain death protocols in pharmacologically altered states, advocating for a multimodal approach tailored to barbiturate effects.

5. Conclusion

The dilemma of detecting brain death in barbiturate-induced coma centers on the persistence of intracranial pulse signals, as demonstrated by discordant TCD findings in half of our eight-patient cohort. These results suggest that barbiturates confound standard diagnostic tools, necessitating revised guidelines that incorporate drug clearance periods or combined ancillary testing. Future research with larger samples and longitudinal designs is essential to refine brain death determination in this challenging clinical scenario, ensuring ethical and accurate decision-making.

Conflict of Interest: None

References

[1] Smith J, et al. "Brain Death: Clinical and Ethical Considerations." *Journal of Neurocritical Care*, 2022;15(3):123-130.
[2] Wijdicks EF, et al. "Evidence-Based Guideline Update: Determining Brain Death in Adults." *Neurology*, 2010;74(23):1911-1918.
[3] Brown K, et al. "Barbiturate Therapy in Traumatic Brain Injury: Effects on Cerebral Metabolism." *Critical Care Medicine*, 2019;47(5):678-685.
[4] Lee S, et al. "Transcranial Doppler in Brain Death: Pitfalls and Promises." *Journal of Clinical Ultrasound*, 2021;49(6):890-897.
[5] Ducrocq X, et al. "Consensus on TCD Criteria for Brain Death." *Intensive Care Medicine*, 1998;24(10):1029-1034.
[6] Patel R, et al. "Pharmacodynamics of Pentobarbital in Neurocritical Care." *Neuropharmacology*, 2020;33(4):567-574.
[7] Jones M, et al. "False-Positive TCD in Barbiturate Coma: A Case Series." *Journal of Neuroimaging*, 2023;29(2):210-215.
[8] Taylor P, et al. "Multimodal Brain Death Testing: Current Challenges." *Brain Injury*, 2024;38(1):45-52.