

Temporal changes in the brain in neonatal hydrocephalic mice: structural and neurobehavioural findings

Omowumi M. Femi-Akinlosotu¹, Anita Naicker², Matthew T. Shokunbi^{1,3}

1 Department of Anatomy, College of Medicine, University of Ibadan. Nigeria.

2 Optics & Imaging Centre, School of Laboratory Medicine and Medical Sciences, College of Health Sciences, University of KwaZulu-Natal, Durban. South Africa

3 Department of Surgery, College of Medicine, University of Ibadan. Nigeria

mtshokunbi@com.ui.edu.ng; temitayoshokunbi@yahoo.com

In hydrocephalus, the circulation of cerebrospinal fluid is altered leading to its accumulation in the ventricles and subarachnoid space. The impact of this disease on neurobehaviour and the structure of the cellular organelles of pyramidal neurons and their synapses in the neonatal hydrocephalic mouse brain overtime are not fully understood.

Hydrocephalus was induced in day-old mice by intra-cisternal injection of sterile kaolin suspension. The pups were tested for reflex developments prior to sacrifice on postnatal days 7,14,21. Cortical thickness and neuronal density in the sensorimotor cortex were evaluated using hematoxylin and eosin and Nissl stains while ultrathin stained sections were also assessed.

Surface righting reflex (3.08 ± 0.48 vs 1.27 ± 0.16 ; 2.49 ± 0.10 vs 1.06 ± 0.05) and cliff avoidance activities (17.15 ± 2.18 vs 10.50 ± 2.00) were significantly impaired in hydrocephalic pups. The cortical thickness (μm) of the hydrocephalic mice was significantly reduced on PND 7 (2409 ± 43.37 vs 3752 ± 65.74), PND 14 (2035 ± 322.10 vs 4273 ± 67.26) and PND 21 (1676 ± 33.90 vs 4945 ± 81.79) compared to controls. Compared with age-matched controls ($129.60 \pm 3.72 \times 10^{-6} \mu\text{m}^2$; $230.0 \pm 44.1 \times 10^{-6} \mu\text{m}^2$), the neuronal density of the sensorimotor cortex in hydrocephalic mice was significantly increased on PND 14 ($157.70 \pm 21.88 \times 10^{-6} \mu\text{m}^2$) and PND 21 ($373.20 \pm 21.54 \times 10^{-6} \mu\text{m}^2$). The TEM of the hydrocephalic mice brains showed loss of structural integrity of cellular organelles and depletion of synaptic junctions. The synaptic densities (per $\mu\text{m}^2 \times 10^{-5}$) of the hydrocephalic mice were significantly lower (188.0 ± 22.67 ; 120.0 ± 21.68 ; 72.0 ± 0.66) than their age-matched controls (336.0 ± 37.09 ; 486.0 ± 18.60 ; 600.0 ± 17.61) on days 7, 14 and 21 respectively.

The quantitative changes and ultrastructural findings seen in the neuronal population of the hydrocephalic mice may provide supportive data for the structural basis of the neurological disabilities associated with neonatal hydrocephalus.