Choroid plexus morphology in substance abuse

Angelica Pham
The University of Texas Rio Grande Valley School of Medicine, angelica.pham01@utrgv.edu

Alan N. Francis
The University of Texas Rio Grande Valley School of Medicine

Choroid plexus morphology in substance abuse: a systematic review

Pham, A.[1], Francis, A., PhD[1]
[1]University of Texas Rio Grande Valley

Background: The choroid plexus (CP), a highly vascularized organ that lines the ventricles of the brain, serves several important functions that maintain homeostasis of the cerebrospinal fluid (CSF) surrounding the brain and protects the brain from harm by acting as part of the blood-cerebrospinal fluid barrier. Dysfunction in CP morphology and function has recently been associated with various conditions such as stroke, aging, neoplasms, hydrocephalus, Alzheimer's disease, depression, and psychosis. This systematic review explores the morphological changes in the CP associated with substance abuse, which poses a significant problem worldwide.

Methods: A comprehensive literature search was performed to find relevant articles using PubMed, Web of Science, MEDLINE, and Google Scholar. Commonly abused substances such as alcohol, cocaine, cannabis, methamphetamine/amphetamine, opioids, hallucinogens, tobacco/nicotine were searched, however, only studies studying CP morphological changes from alcohol, cocaine, methamphetamine, tobacco/nicotine, and opioids (morphine) were found. Articles were selected based on whether CP morphology in the use of illicit substances was assessed using imaging techniques such as magnetic resonance imaging, computed tomography, ultrasound, light microscopy, and transmission electron microscopy. Studies featuring animals or the effects of substance use in pregnant mothers and their embryos or fetuses were included.

Results: The results showcase morphological changes of the CP that may be observed in the context of the previously mentioned substances. Alcohol consumption during pregnancy was associated with abnormalities in CP epithelium. Studies reported CP hyperplasia or agenesis, increased lateral ventricle volume, decreased glycogen content, and enlarged intercellular spaces. In rats, ultrastructural changes including dilated intercellular spaces, disrupted mitochondria, aggregation of primary and secondary lysosomes, and vacuoles within the cytoplasm were observed. Cocaine use was found to potentially induce CP damage. In rats, vacuolization, necrosis, and lesions CP blood vessels were discovered. Human maternal cocaine use displayed cases of CP cysts across different studies, but a direct correlation could not be established. Methamphetamine administration in rats resulted in increased CP volume, destroyed nuclei, and elevated capillary quantity. Oral morphine administered to rats led to dysfunctional synthesis and secretion of CSF, resulting in decreased cavity surface area and increased CP surface area. Maternal smoking was found to have a significant impact on the CP of the fourth ventricle in fetuses and infants who were victims of sudden death syndromes.

Conclusion: These findings highlight the vulnerability of the CP to substance use and its potential impact on CSF production, CSF homeostasis, and brain development. Definitive conclusions on the effects of substance use on the CP were difficult to establish due to the presence of confounding variables in many studies. Understanding these effects may provide insight into pathological mechanisms associated with substance use and contribute to the development of targeted treatments and prevention. Because this is an understudied topic, further research is necessary to study the complex interaction between substance abuse and the CP, considering confounding variables and an emphasis on non-invasive imaging techniques to translate research to adult humans.