Growth and Development of the Brain and Impact on Cognitive Outcomes

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Understanding human brain development from the fetal life to adulthood is of great clinical importance, as many neurological and neurobehavioral disorders have their origin in early structural and functional cerebral maturation.

The developing brain is particularly prone to being affected by endogenous and exogenous events through the fetal and early postnatal life. The concept of ‘developmental plasticity or disruption of the developmental program’ summarizes these events.

Increases in white matter, which speed up communication between brain cells, growing complexity of neuronal networks suggested by gray and white matter changes, and environmentally sensitive plasticity are all essential aspects in a child’s ability to mentalize and maintain the adaptive flexibility necessary for achieving high sociocognitive functioning.

Despite marked improvements in perinatal practice, perinatal brain injury and alteration of brain development remains one of the most common complications of premature birth causing chronic handicapping conditions.

During the past 15 years, the etiology of brain injury in human newborns has been considered by many to be multifactorial rather than only linked to cardiovascular instability and hypoxia-ischemia. Several prenatal, perinatal and postnatal factors (such as hypoxic-ischemic insults, excess release of glutamate, genetic factors of susceptibility, growth factor deficiency, oxidative stress, maternal infection yielding excess cytokines, exposure to toxins, maternal stress and malnutrition) have been implicated in the pathophysiology of brain lesions and developmental abnormalities associated with cerebral palsy and neurocognitive delay.

Advancement in neuroimaging has opened up new ways for examining the developing human brain in vivo, the study of the effects of
early antenatal, perinatal and neonatal events on later structural and functional brain development resulting in developmental disabilities or developmental resilience. In this review methods of quantitative assessment of human brain development, such as 3D-MRI with image segmentation, diffusion tensor imaging to assess connectivity, and functional MRI to visualize brain function, will be presented.