Parenteral nutrition and brain development after preterm birth

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Preterm infants have a higher incidence of developmental disability, including neurocognitive and neurobehavioral abnormalities, and more so when born earlier in gestation. Provision of adequate nutrition is critical for neurodevelopment of preterm infants and parenteral nutrition (PN) is essential for preterm infants intolerant of enteral nutrition (EN). While investigating the preterm pig as a model for PN associated liver disease we discovered growth and maturation of the brain after preterm birth is also compromised by PN. Preterm pigs delivered at 92% of gestation and representative of 32 week preterm infants were provided PN for 24 h before 10 more days of nutritional support provided either by continued PN or conversion to full EN using formula that provided comparable fluid volumes, energy, and nutrients. Although initial and final body weights were similar, pigs dependent on PN did have larger livers ($P<0.05$) without overt signs of pathology. Surprisingly, the brains of PN pigs were 13% smaller compared with EN pigs ($P<0.01$) with reduced myelination of major CNS nerve tracts based on diffusion tensor imaging. Assessments of activity revealed a rapid divergence between PN and EN pigs ($P<0.01$) and after 10 days neurocognitive skills of PN pigs were diminished ($P<0.02$) and the delayed development of motor skills corresponded with a smaller cerebellum. The PN pigs had significantly lower serum cholesterol, including HDL cholesterol that was also less functional. The compromised brain development associated with PN is a novel finding and highlights the need to better understand nutrient requirements of preterm infants, the route by which nutrition support is delivered, and the role of serum lipids in neurodevelopment.