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Evaluation of Developmental Toxicity and Teratogenicity of Perfluoroalkyl Compounds Using FETAX

Authors : Hyun-Kyung Lee, Jehyung Oh, Young Eun Jeong, Hyun-Shik Lee

Abstract : Perfluoroalkyl compounds (PFCs) are environmental toxicants that persistently accumulate in the human blood. Their widespread detection and accumulation in the environment raise concerns about whether these chemicals might be developmental toxicants and teratogens in the ecosystem. We evaluated and compared the toxicity of PFCs of containing various numbers of carbon atoms (C8-11 carbons) on vertebrate embryogenesis. We assessed the developmental toxicity and teratogenicity of various PFCs. The toxic effects on Xenopus embryos were evaluated using different methods. We measured teratogenic indices (TIs) and investigated the mechanisms underlying developmental toxicity and teratogenicity by measuring the expression of organ-specific biomarkers such as xPTB (liver), Nkx2.5 (heart), and Cyl18 (intestine). All PFCs that we tested were found to be developmental toxicants and teratogens. Their toxic effects were strengthened with increasing length of the fluorinated carbon chain. Furthermore, we produced evidence showing that perfluorodecanoic acid (PFDA) and perfluoroundecanoic acid (PFuDA) are more potent developmental toxicants and teratogens in an animal model compared to the other PFCs we evaluated [perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA)]. In particular, severe defects resulting from PFDA and PFuDA exposure were observed in the liver and heart, respectively, using the whole mount in situ hybridization, real-time PCR, pathologic analysis of the heart, and dissection of the liver. Our studies suggest that most PFCs are developmental toxicants and teratogens, however, compounds that have higher numbers of carbons (i.e., PFDA and PFuDA) exert more potent effects.

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