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Stress and Insufficient Nutrition Program Abnormal Growth of the Embryo

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[Background and Objectives] Stress and insufficient nutrition in fetal life impose a risk of low birth weight (LBW) and increased vulnerability to chronic childhood and adult diseases. Using a unique avian model, we reported previously that impaired nutrition caused LBW and, after maturation, a low number of nephrons, enhanced glomerular apoptosis, plus glomerular mesangium lesions partly resembling nephrosclerosis. The current study aims to determine whether stress imposed on the embryo during the early period of development induces structural defects, whereas insufficient nutrition causes impaired growth and maturation. We also examined whether α -smooth muscle actin (α -SMA) may serve as an injury/inflammation marker in glomerular mesangium.

[Methods] Using a sterile technique, 8-10% of the egg white (92% of solid constituents is protein) was withdrawn (EwW) from eggs of Japanese quail, *Coturnix japonica* (GQF MFG Co.; Savannah, GA) by gentle suction via a G18 blunt needle before the start of incubation (37.6°C, 70% humidity). Control (CT), EwW, and sham control (SH, 30-50% of withdrawn egg white was immediately returned to the egg) were examined for body growth (BW), morphology, and α -SMA expressions of the kidney.

[Results] We found: 1) At embryonic day 8-9 (E8-9), 45.1% (n = 31) of embryos derived from EwW eggs showed abnormal growth, malformation, and/or early death. At E15-16 (hatch, E17), the rate of abnormal growth/structure was lower (26.4%, n = 34). 2) The BW of the EwW embryos that showed good growth with vital signs (0.74 ± 0.03 g, n = 8) was not significantly different from that of CT (0.79 ± 0.02 g, n = 14) or SH (0.83 ± 0.04 , n = 4) at E8-E9, but it was lower ($P < 0.01$) at E16 (CT, 5.9 ± 0.2 g, n = 13; EwW, 5.2 ± 0.1 g, n = 14). BW of SH was also significantly lower (4.0 ± 0.5 , n = 3, $P < 0.01$) than CT at E16. 3) α -SMA was expressed in renal arteries and arterioles, glomerular mesangium, and interstitial pericytes of embryonic kidneys. α -SMA expression in the glomerular mesangium was stronger in EwW groups (E16).

[Summary and Conclusion] These results suggest that partial withdrawal of egg white before incubation induces structural defects and early death, possibly due to the mechanical stress of egg white withdrawal, whereas the effect of low nutrition was more obvious in the later embryonic period. A partial return of egg white may have imposed more stress. α -SMA in glomerular mesangium may serve as an injury/inflammation marker in quail kidneys. Disorders with developmental origins will impose significant impacts on child health and welfare, and public economy. (NIH DK091330 and DK096373; Grant-in-Aid from Ministry of Education, Culture, Sports, Science and Technology in Japan)