It is well known for higher vertebrates that the thyroid gland influences metabolic rate. If thyroid hormones similarly affect metabolism in elasmorbranchs and circulating levels were high in the mother as a result of the adenoma, the maintenance metabolism of the young may have been increased, and consequently more of the yolk reserves utilized. Since the mother does not contribute to the nutrition of the young during pregnancy, and the embryo is, in this respect, a "closed" system, any increased utilization for maintenance metabolism might well result in a smaller body weight, as less energy is available for growth.

DRAINAGE OF INTERSTITIAL FLUID FROM BRAIN IN THE LITTLE SKATE (RAJA ERINACEA)

Helen F. Cserr, Nicholas Bradbury and Daniel G. Gomez, Dept. of Physiology, Brown University, Providence, RI 02912 and Dept. of Radiology, Cornell University Medical College, New York, N.Y. 10021

The classical view of the drainage of interstitial fluid (ISF) from brain is of a flow of perineuronal fluid into a canalicular system of perivascular spaces with eventual drainage into cerebrospinal fluid (CSF). Recent experiments in rat and rabbit have confirmed this view; they also indicate additional pathways of ISF drainage from brain, namely into blood vessels in the choroid plexus, along the optic and olfactory nerves, and into the deep cervical lymphatics (Cserr et al. Exp. Eye Res., Suppl. Vol. 25:461-473, 1977; Cserr & Bradbury, In Preparation). In order to investigate these extra-CSF pathways of fluid removal from brain we have studied the flow of cerebral ISF in the little skate, Raja erinacea. In this species the ventricular cavities are extremely reduced and there is no subarachnoid space.

Three test compounds were employed as markers of ISF flow: albumin complexed to Evans Blue (EBA), horseradish peroxidase (HRP), and radioiodinated serum albumin (RISA). Balanced saline solution containing one of the test compounds was injected slowly into the telencephalon (< 0.3 µl/min) through a 30 gauge cannula attached via teflon tubing to a Harvard infusion pump. Channels of flow were then identified as the pathways of distribution away from the injection site.

In initial experiments with EBA, 2 to 14 µl of dye solution (2.5 protein; 5% dye) was injected into brain and the subsequent appearance and distribution on the dorsal surface of the brain observed for 1 to 3 hours through a dissecting microscope (N=5). The pathways of flow outlined by the blue dye indicated that flow follows the course of blood vessels. The marker could not be followed for more than 1 to 2 cm from the injection cannula, however, presumably because of dilution of the test compound.

In order to investigate the pathways of flow and drainage with greater resolution and sensitivity we used the protein tracer HRP. One µl of a 30% solution of Sigma's type VI HRP was injected into the telencephalon. The skates were sacrificed either 15 min (N=4), 4 hr (N=4) or 24 hr (N=4) after injection and the brain fixed by vascular perfusion with a mixed aldehyde fixative. The fixed tissues were reacted for peroxidatic activity and processed for light or electron microscopy. Preliminary examination at the light level confirms the role of perivascular spaces as preferential channels for the flow of ISF. Also in agreement with previous work, the histological distribution of HRP in the skate indicates flow of ISF to the subependymal layer and between ependymal cells to the ventricular lumen. HRP was also seen in the lumen of some superficial veins associated with the meninges. These observations will be extended to the electron microscopic level.

The elasmobranch brain is surrounded by extradural fluid (EDF). Results with the three protein tracers indicate exchange between this fluid and the brain in the little skate. HRP and RISA distributed to EDF following intracerebral injection and EBA stained perivascular spaces surrounding the superficial meningeal vessels following injection into EDF. These results are at variance with the generally accepted view that EDF is isolated from the brain by a brain-EDF barrier.

This work was supported by U.S. Public Health Service Grants NS11050 and NS13844.