KIDNEY FUNCTION
in
THE OVINE FOETUS

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SUMMARY

Catheters were inserted into the femoral artery and vein, urinary bladder and amniotic sac of foetal sheep and samples were collected daily during the last 35 days of gestation. Analysis of these samples revealed changes in the composition of foetal urine that were significantly correlated with foetal age. A series of experiments involving the administration of hormones and diuretic chemicals was then carried out in an attempt to determine the cause of the changes in urine composition. Kidney morphology was also examined.

Foetal glomerular filtration rate (GFR) was found to increase progressively and mature foetuses were able to increase GFR by as much as 80%. The diuretic experiments confirmed the existence of active Na\(^+\) reabsorption in the foetal nephrons and the reabsorption appeared to be linked to K\(^+\) secretion. The Na\(^+\) reabsorption was also accompanied by passive water reabsorption. Carbonic anhydrase activity in the foetal nephrons and its involvement in Na\(^+\) - H\(^+\) exchange, was also demonstrated. With respect to maturational changes, evidence was obtained that the capacity for Na\(^+\) reabsorption in the loops of Henle increases with gestational age, as well as distal Na\(^+\) - K\(^+\) and Na\(^+\) - H\(^+\) exchange. The hormone administration experiments indicated that during the last 35 days of pregnancy, aldosterone promotes Na\(^+\) retention and that cortisol has a mild natriuretic and diuretic effect. Also dexamethasone administered alone, or in combination with metyrapone, produced changes in urine output and composition that were consistent with the existence of pituitary-adrenal interactions in the foetus, 11\(\beta\) hydroxylase activity in the foetal adrenals and responsiveness of the foetal kidneys to 11-desoxycorticosteroids. Other hormones including progesterone, ADH and angiotensin produced variable
effects on urine composition, but ADH and angiotensin reduced urine output, presumably by increasing renal vascular resistance. These hormone experiments were of a preliminary nature and further work will be necessary to confirm the observations made. Nevertheless on the basis of these experiments and the observed relationship between endogenous hormone levels and normal urinary parameters; it is suggested that increasing plasma renin activity plus a greater capacity for Na\(^+\) reabsorption was responsible for the decrease in urinary Na\(^+\) concentration that occurred prior to the 145th day of pregnancy. However, the proparturient increase in urinary Na\(^+\) concentration and Na\(^+\) excretion rate is thought to have been due to a rise in GFR induced by an increase in plasma cortisol concentration. Because of Na\(^+\) - K\(^+\) exchange in the foetal nephrons, these factors also appear to have influenced urinary K\(^+\) concentration during gestation. The urinary concentrations and excretion rates of uric acid and urea were related to the gradual increase in GFR that occurs prior to day 145 and to the exponential increase in GFR during the last five days of pregnancy.

The ability of the foetal kidney to compensate for disruptions to normal fluid and electrolyte balance within the foetus was also studied. This ability was apparent in foetuses older than 115 days, irrespective of whether the disruptions were the result of direct manipulation of foetal body fluids or indirect disruptions consequent upon changes in the composition of maternal body fluids or amniotic fluid. The renal mechanisms involved in these homeostatic activities included both changes in GFR and changes in the reabsorptive activity of the renal tubules. The relative involvement of each appeared to be a function of foetal age and the nature of the imbalance in the internal environment of the foetus.