observation). The fact that those results were repeatable would suggest the receptors were not extensively damaged. One possible explanation is that the responses were originating from nociceptors in an area of the mouth where there had been some pathological change (e.g., buccal erosion) which was not clearly visible.

It is not surprising that the CT showed a clear response to cooling of the mouth as cold receptors have been identified in both the lingual[11] and trigeminal nerves[18,19].

The persistent responses to drying of the buccal epithelium is of considerable interest. It is too early to speculate as to the nature of the receptors involved but it does suggest that it may be the physiological basis of the dry mouth sensation which is often used to explain prandial drinking in animals fed a dry diet.

In conclusion the CT, in addition to the preganglionic parasympathetic fibers which it was generally considered to contain, contains a wide variety of afferent sensory fibers giving information to the bird about taste, touch, temperature and pain.

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Liver function during chronic renal failure in rabbits

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Summary. In rabbits with chronic renal insufficiency the prothrombin index was increased by 25% and the alanine aminotransferase activity decreased by 20%; the results of other routine tests of hepatic function were not affected. The galactose elimination capacity was decreased by 12%, whereas the body clearance of antipyrine was unchanged. No change in hepatocytic structure was found.

Key words. Rabbits; renal failure, chronic; liver function; prothrombin index.

Evidence of altered liver function in patients with chronic renal failure (CRF) consists of increased serum levels of various coagulation factors[2,3], decreased activity of serum transaminases[4] and altered hepatic drug metabolism[5]. The present study concerns quantitative and qualitative measures of hepatic function and liver morphology in rabbits with CRF.

Material and methods. Chronic renal failure (CRF) was induced in young adult male rabbits of the White Danish Country strain by a 2 step procedure. During general anesthesia two-thirds of the surface of the left kidney was cauterized through an abdominal incision and 3 weeks later the right kidney was removed[6]. Control rabbits were sham-operated twice. Three months after surgery the glomerular filtration rate was measured as the total plasma clearance rate of ^{51}Cr-EDTA[6]. The galactose elimination capacity (GEC) was measured by injecting a weighed amount of galactose (4 mmol/kg b.wt) i.v. and during the next 3 h 15–19 arterial blood samples were obtained. The urinary bladder was emptied and irrigated with 2 × 10 ml of isotonic saline. The galactose concentrations in blood and urine samples were determined enzymatically[7]. The GEC was calculated as $\frac{A-U}{t_{c=o}+7}$, where A is the amount of galactose injected, U the amount excreted in the urine, $t_{c=o}$ the intercept on the time axis of the linear regression of arterial galactose concentration with time, and 7 is a correction for the equilibration of galactose during the elimination[8]. The regression analysis included samples obtained from 25 min after the injection until the concentration was below 2 mmol/l.

The clearance of antipyrine was determined by injecting a weighed amount of antipyrine (60 mg/kg b.wt) into an ear vein. Four venous blood samples were drawn from the other ear 3–7 h after the injection and analyzed for antipyrine[9]. The clearance was calculated from the linear regression of log concentration over time as clearance = $k \cdot \text{dose}/C_0$, where k is the elimination konstant and C_0 is the extrapolated concentration at time zero.

The serum concentrations of creatinine, urea, protein and bilirubin and the activities of alkaline phosphatase and alanine aminotransferase were measured by an autoanalyzer (ACA, Dupont Instruments). Albumin was determined by the succinic acid buffer method and the prothrombin index by the Owrens

Parameters of renal and hepatic function in rabbits with chronic renal failure (CRF) and normal controls

	CRF n = 8	Controls n = 6		CRF n = 8	Controls n = 6
Body weight (kg)	3.20 (2.91–3.36)**	3.49 (3.24–3.87)	Alanine aminotransferase (units/l)	53 (29–65)*	67 (38–86)
Creatinine (mmol/l)	0.19 (0.14–0.34)**	0.10 (0.07–0.11)	Prothrombin index	0.42 (0.32–0.53)*	0.34 (0.24–0.44)
Carbamide (mmol/l)	12.0 (9.4–15,2)**	6.6 (5.0–8.4)	Galactose elimination capacity (μmol/kg·min)	22.5 (16.8–27.3)*	25.6 (20.0–34.2)
^{51}Cr-EDTA-clearance (ml/kg·min)	2.1 (1.5–2.8)**	4.3 (3.2–7.2)	Antipyrine clearance (l/kg·h)	5.9 (4.9–7.7)	4.8 (4.5–7.9)

Values are medians with the range in brackets. Significance levels for the differences between the two groups are indicated as *$0.05 < p < 0.10$ and **$p < 0.01$.

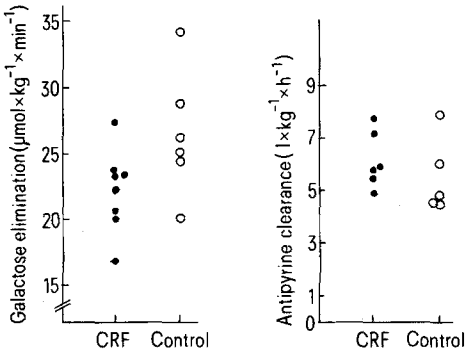
method[10]. The 2 groups were compared by the Mann-Whitney rank sum test.

After sacrifice, specimens of the livers were fixed in 10% formalin and processed routinely for light microscopy. Tissue for transmission electron microscopy was fixed in a buffered 3% solution of glutaraldehyde, post-fixed in osmium tetraoxide and embedded in Epon[11]. For examination ultrathin sections were contrasted with uranyl acetate and lead citrate.

Results. The body weight of the CRF rabbits was slightly decreased, the ^{51}Cr-EDTA clearance was halved and the serum concentrations of creatinine and urea were doubled (table). The serum albumin, protein and bilirubin, and the hematocrit values, were similar in the 2 groups. The median prothombin index in the CRF group was 23% higher than in the control rabbits ($0.05 < p < 0.10$). The alkaline phosphatase activity was similar in the 2 groups, whereas the alanine aminotransferase activity in the CRF rabbits was only 79% of the level in controls ($0.05 < p < 0.10$). The clearance of antipyrine was not affected by CRF and the median value of the distribution volume was 0.63 l/kg in both groups. In the CRF rabbits the median GEC was 85% of the value in controls ($0.05 < p < 0.10$, table, fig.).

Light microscopy of the livers revealed slight periportal hypercellularities consisting of mononuclear cells and some eosinophils, found in 4 of the 8 CRF rabbits. The normal ordered structure of the tissue was intact, the hepatocytes appeared normal and there was no change in the bile ducts, Kuppfer cells or the connective tissue. At the ultrastructural level the hepatocytes from CRF rabbits did not differ from those of controls either in the distribution, number or the structure of the organelles.

Discussion. In the present study no significant differences between CRF rabbits and normal controls were demonstrated in any of the measures of liver funciton. The relatively moderate degree of CRF obtained might have been decisive for this outcome. The GEC reflects cytosolic hepatocytic function and is a measure of funcitonal liver mass[12]. In the CRF rabbits this parameter was insignificantly decreased compared to controls.



Galactose elimination capacity and clearance of antipyrine in rabits with chronic renal failure (CRF, ●) and normal renal function (control, ○).

The microsomal oxidative drug metabolizing capacity of the liver as measured by the antipyrine clearance was not affected in our CRF rabbits, in contrast to clinical experience[5]. Both induction and inhibition of hepatic drug metabolism have been described during CRF in man[13], and in uremic rabbits decreased metabolism of warfarin has been found[14]. The prothrombin index, which is an indicator of hepatic protein synthesis capacity[15], was marginally increased in the CRF rabbits. The mechanism for the increased coagulation factors in uremic patients is not known[2,3].

Several transaminase activities in serum are commonly measured to evaluate liver function and only an insignificant decrease in the alanine aminotransferase activity was registered in the CRF rabbits. In uremic patients the transaminase activity is decreased[4], probably due to the accumulation of an inhibitory, dialyzable substance[16].

The effect of CRF on liver morphology has not been studied systematically in man. In uremic rats disorganization of the hepatocytic mitochondria has been described[17]. In our CRF rabbits no change in hepatocytic structure was found and we have no explanation for the occurrence or importance of the periportal hypercellularities observed.

The results of the present study indicate that mild azotemia in rabbits is not associated with significant changes in hepatic function or morphology.

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