THE FUNCTION OF THE RENAL PELVIS IN THE HAMSTER (*Mesocricetus auratus*)

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In the mammalian kidney urine leaving the ducts of Bellini is at times swept retrograde into the pelvi where it bathes the renal medulla (Schmidt-Nielsen, Fed. Proc. 36:2493-2503, 1977). The renal pelvic extensions, the so-called fornices and secondary pouches (Lacy and Schmidt-Nielsen, MDIBL Bull. 16:74-76, 1976) provide for extensive contact between pelvic urine and the inner as well as the outer medulla of the kidney. In the present experiments the function of the renal pelvis in the golden hamster was studied usi micropuncture and tissue analyses techniques.

The animals were maintained on either a regular diet (Old Guilford Jax Lab. diet 96) or special high and low protein diets (Zeigler Bros. Inc.). The hamster was anesthetized with Inactin (15 mg/100 g hamste initially). When fully anesthetized, it was placed on a heated table to maintain the body temperature at 35-57°C. The right jugular vein was catheterized, and the right kidney was exposed through a flank incision. The kidney was then decapsulated and placed in a small plastic cup or dish as is normally done for micropuncture studies (Windhager, Micropuncture Techniques and Nephron Function, Butterworth, London, 19

The fat over the renal pelvis and part of the ureter was removed without opening the pelvis. Followin i.v. injection of a bolus of 2% lissamine green in saline (0.2 ml), the movement of urine in the collectin ducts, pelvis and ureter became clearly visible through the transparent pelvic wall. In about half of the experiments the animal was given 100 µCi of ^{3}H inulin and 30 µCi of ^{14}C urea. One hour later micropunctur samples of fluid from the ducts of Bellini (DB), pelvis (P) and ureter urine (U) were taken in rapid succession. The contractions of the pelvis, the reflux of urine and the movement of urine in the collecting ducts were studied at 50 to 100x magnification. Color movies and photographs were also taken through the microscope.

Urine does not always flow retrograde into the pelvis. Extensive reflux was seen particularly follow i.v. injection of saline (0.2 to 0.4 ml). The reflux would continue for 10-15 minutes and then gradually subside. Reflux of urine was also increased when the ureter was lifted slightly.

Preliminary studies showed that the osmolality of DB was consistently the highest of the three fluids, and P consistently the lowest (DB > U > P). This observation alone could not explain whether solutes were leaving the fluid bathing the papilla or water was being added. In studies where ^{3}H inulin and ^{14}C urea were used, it was seen that the urea concentration was usually lower in P than in DB and U (Figure 1). The

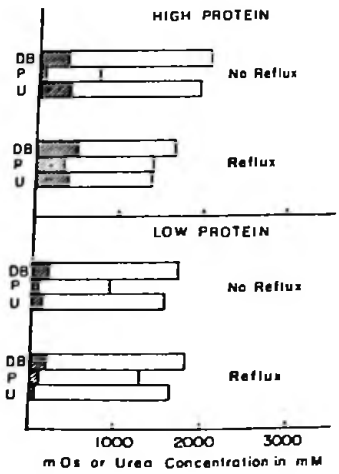

Figure 1. The bars show the osmolality (white) and urea concentration (crosshatched) of the three samples from four representative animals. The calculated data on percent of filtered load present in the sample (same four animals) are shown in Table 1.

difference was greatest when the reflux of urine into the pelvis was not clearly visible. In Table 1 data from the same four animals are shown as percent of filtered load present. It appears that some fluid is always being added in the pelvis. However, the amount was negligible since the fraction of filtered water was not greater in U than in DB. On the other hand the urine flowing down the ureter had a lower fraction of filtered solutes and urea than the fluid leaving the ducts of Bellini; indicating recycling of urea and other solutes back into the renal parenchyma. This was most pronounced when reflux was visible.

TABLE 1

PERCENT OF FILTERED LOAD PRESENT IN SAMPLE

	Water	Osm	Urea
	Inulin P/U 100%	$\frac{U/P\ Osm}{U/P\ Inulin}100\%$	$\frac{Urea}{U/P\ Inulin}100\%$
HIGH PROTEIN			
No Reflux of Urine			
Ducts of Bellini	.49	3.67	18.0
Pelvis	16.2	44.16	148.0
Ureter	.37	2.62	15.5
Reflux of Urine			
Ducts of Bellini	.35	2.14	18.2
Pelvis	.42	2.15	14.0
Ureter	.37	1.88	15.0
LOW PROTEIN			
No Reflux of Urine			
Duct of Bellini	.42	2.65	12.8
Pelvis	10.01	33.0	115.5
Ureter	.44	2.60	11.5
Reflux of Urine			
Duct of Bellini	.43	2.60	12.9
Pelvis	.49	2.10	10.3
Ureter	.36	1.90	5.7

When the renal papilla is observed through the transparent wall of the pelvis, it is seen to contract. The rate is 10-15 contractions per minute under our experimental conditions. The urine in the collecting ducts does not move continuously through the ducts. Two patterns of movement can be observed: (1) The visible part of the collecting ducts fills with urine, and the urine remains there until the papilla contracts (usually 3-6 seconds). Then the collecting ducts fill immediately; (2) The visible part of the collecting ducts are empty most of the time, then just before the contraction, the urine sweeps through the ducts at a rate of 1 to 3 mm/sec. These two patterns appear to be related to diet.

The observations indicate a role of the renal pelvis in solute recycling via the pelvis. The observed discontinuous movement of urine through the collecting ducts is likely to be of profound physiological importance. This study was supported by NIH grant 5 R01 AM 15972.