Calculation of Renal Arteriolar Resistance

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New micropuncture techniques developed over the past years make it possible to measure glomerular and peri-tubular capillary pressure and on the basis of these parameters to calculate afferent (Ra) and efferent (Re) resistance of a single superficial nephron [1]. The sum $R_a + R_e$ indicates the renal arteriolar resistance.

In clinical investigations and in experiments on intact animals it is customary to estimate renal vascular resistance as the ratio of arterial pressure (AP) and renal blood flow (RBF). This is a simplistic application of Ohm's law.

This study was undertaken to investigate how precisely the calculation of AP/RBF indicates the renal arteriolar resistance. In experiments on dogs we have therefore measured the haemodynamic parameters using the micropuncture technique and simultaneously the total RBF was estimated on the basis of the PAH clearance.

The experiments were carried out on 8 mongrel dogs of either sex, body weight 16-20 kg. In pentobarbital anaesthesia isolated kidney was pump-perfused by another dog without RBF interruption. A servo-nulling device was used for measurements of glomerular and peritubular capillary pressure [2]. The kidneys were perfused at pressures 8.0, 17.3 and 21.3 kPa.

The arteriolar resistance of a single superficial nephron was calculated according to the formula:

tr 20

20 40 60 80 100 120 140

(kPa·min⁻¹)

PP

RBF

Fig. 1. Relationship between the arteriolar resistance ($R_a + R_e$) of a single superficial nephron and the ratio of perfusion pressure and single nephron glomerular blood flow.

$R_a + R_e =$
 $\frac{PP - GCP}{SNGBF}$
 $\frac{GCP - PCP}{SNGBF - SNGFR}$

(1)

20 30 40 50

$\frac{Ra+Re}{60} (Pa \cdot min^{-1} \cdot l^{-1})$

60

where PP = perfusion pressure, GCP = glomerular capillary pressure calculated as the sum of the stop-flow pressure in the proximal convolute tubule and systemic arterial oncotic pressure, PCP = peritubular capillary pressure, SNGBF = single nephron glomerular blood flow, SNGFR = single nephron glomerular filtration rate.

Figure 1 shows the relationship between the arteriolar resistance ($R_a + R_e$) of a single superficial nephron and the ratio PP/RBF. It is evident that there is a highly significant correlation between these values. The value of regression coefficient is 1.03, indicating that the renal venular resistance is negligible in comparison with the arteriolar resistance.

Figure 2 shows the relationship between $R_a + R_e$ of a

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single superficial nephron and the ratio of PP/RBF. It is evident that there is a significant correlation between these values. In the interpretation of the scatter of the values it should be taken in account that the conductance (reciprocal value of the resistance) of the kidney is given by the sum of the conductances of the individual nephrons:

$$\frac{1}{\frac{PP}{RBF}} = \frac{1}{\frac{PP}{SNGBF_1} + \frac{PP}{SNGBF_2} + \dots + \frac{PP}{SNGBF_n}}$$

PP/RBF (or AP/RBF) provides accurate enough information about the renal arteriolar resistance.

References

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where N = number of functioning nephrons. It follows from the equation 2 that the scatter in the relationship between $R_a + R_e$ and PP/RBF ratio may be caused either by the inequality of SNGBF of individual nephrons or by the inequality of N of the investigated kidneys. The results obtained show that calculation of the ratio