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A COMPARATIVE STUDY OF RENAL FUNCTION IN THE DROMEDARY AND SHEEP USING THE SINGLE INJECTION TECHNIQUE WITHOUT URINE COLLECTION

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ABSTRACT

Glomerular filtration rate (GFR) and effective renal plasma flow (ERPF) were compared in dromedary and sheep using the single injection technique of inulin and ρ-aminohippuric acid. The GFR (inulin clearance) and ERPF were significantly lower in the dromedary (1.166 and 6.145 ml $min^{-1} kg^{-1}$) than that in the sheep (2.220 and 10.300 ml $min^{-1} kg^{-1}$). In contrast, the inulin space, which estimates extracellular water volume, as well as the filtration fraction were similar in the two species.

Key words : Dromedary, renal function, sheep

Renal function assessment is widely used to elucidate mechanisms underlying body water adjustment in mammals. In comparison with true ruminants, the dromedary possesses a slower body water turnover rate due primarily to reduced water losses by the kidney (Siebert and Macfarlane 1971; Benlamlih *et al,* 1992). Water conservation by the kidney in the dromedary is partly attributed to lower glomerular filtration rate (GFR) and effective renal plasma flow (ERPF) (Siebert and Macfarlane 1971; Etzion and Yagil 1986; Kataria *et al,* 2002). In these studies GFR and ERPF in the dromedary were measured by the constant-infusion technique with timed urine and blood sampling. Such a technique appears cumbersome and may cause animal stress following bladder catheterisation. The single injection technique without urine collection could be a valid alternative to the constant-infusion technique for GFR and ERPF estimation if frequent blood sampling is possible and easier to make than urine collection. Such conditions are met in the dromedary for which urine collection is difficult or even hazardous. The objective of this report was to compare in the dromedary and sheep the GFR and the ERPF using a single injection, without urine collection, of inulin and ρ-aminohippuric acid. With this technique, renal clearance is derived from the plasma disappearance curve of an indicator substance. The advantages and disadvantages of this technique have been discussed elsewhere (Ledegaard-Pedersen, 1972; Levinsky and Levy, 1973 and Brochner-Mortensen, 1985).

Materials and Methods

Three adult female camels (*Camelus dromedarius*) (368 ± 31 kg) and three adult ewes (49 ± 7 kg) were used. The animals were healthy on the basis of clinical examination and were fed barley (3 kg/camel and 500 g/sheep) and had free access to wheat straw and water. Inulin and ρ-aminohippuric acid (PAH) (Sigma Chemical Co., St. Louis, Mo, USA) were dissolved in distilled water and filtered through 0.2 mm membrane before utilisation. Both solutions were administered simultaneously as a bolus *via* a catheter inserted in the jugular vein. Inulin was used at a dose of 15 mg/kg and 30 mg/kg, and PAH at a dose of 10 mg/kg and 20 mg/kg in the dromedary and sheep respectively. The total volume was injected over 30 to 40 seconds. in both species. Blood samples were collected by venepuncture from the other jugular vein in heparinised tubes before dosing and at 2, 4, 8, 15, 30, 60, 90, 120, 150, 180 and 240 min post-injection. After centrifugation, the plasma was stored at –20°C until analysis.

Plasma inulin concentrations were determined using a colorimetric method (Clarke *et al,* 1985) and those of PAH by a high-performance liquid chromatographic technique as described by Oukessou and Toutain (1992).

The inulin and PAH major kinetic parameters were calculated using a non-compartmental analysis based on the statistical moment theory (Gibaldi and

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Perrier, 1982). The total body clearance of inulin and PAH was obtained from the following equation:

Cl_B = Dose/AUC, where AUC is the area under the plasma concentration-time curve calculated by the linear trapezoidal rule. The apparent volume of distribution at steady state of inulin was calculated using the equation: $V_{ss.in.} = Cl_B.MRT$, where MRT is the mean residence time.

Inulin and PAH kinetic parameters obtained for dromedaries and sheep were compared using a Mann-Withney test. A value of $p < 0.05$ was considered significant.

Results and Discussion

The single injection technique, without urine collection, of renal tracers is a generally accepted technique for GFR and ERPF estimation. It has been employed in human being (Ladegaard-Pedersen, 1972; Nielsen 1985; Russell *et al*,1985) and in several animal species including water buffalo (Varma *et al*, 1981), horses (Brewer *et al,* 1988), dogs and cats (Fettman *et al*, 1985) and sheep (Oukessou and Toutain, 1992).

As mentioned above, the renal function has already been studied in the dromedary (Siebert and Macfarlane 1971; Etzion and Yagil 1986; Kataria *et al,* 2002) but as far as is known this is the first experiment in which the dromedary is compared to a true ruminant species using the single injection technique of inulin and PAH. The kinetic parameters calculated for inulin and PAH for dromedaries and sheep are summarised in table 1. The total body clearance of inulin, which estimates the GFR, in the dromedary of 1.166 ± 0.100 ml min^{-1} kg^{-1}, is approximately two times higher than 0.66 ml/min/kg reported by Siebert and Macfarlane (1971), but similar to value (1.185 ml/min/kg) obtained by Kataria *et al* (2002) who used the constant-infusion technique. The values of GFR and ERPF found for the dromedary in the present study (1.166 and 6.145 ml min^{-1} kg^{-1} respectively) were markedly lower than corresponding values in buffalo (3.26 and 10.71 ml min^{-1} kg^{-1}) (Varma *et al,* 1981). Whereas the values calculated for sheep in this study were similar for the GFR (2.22 ml min^{-1} kg^{-1}) but lower for the ERPF (10.30 ml min^{-1} kg^{-1}) than the respective values reported by Kaufman and Bergman (1978) (2.3 and 15.7 ml min^{-1} kg^{-1}) using the constant-infusion technique, and by Oukessou and Toutain (1992) (2.08 and 14.30 ml min^{-1} kg^{-1}) using the single injection technique.

Table 1. Selected kinetic parameters (mean ± SD) of inulin and ρ-aminohippuric acid in the dromedary and sheep.

Parameters	Units	Dromedary	Sheep
$V_{ss.in.}$	(l kg^{-1})	0.132^a ± 0.004	0.134^a ± 0.055
$Cl_{Bin.}$	(ml $min^{-1}kg^{-1}$)	1.166^a ± 0.100	2.220^b ± 0.101
Cl_{BPAH}	(ml $min^{-1}kg^{-1}$)	6.145^a ± 1.205	10.300^b ± 1.640
FF		0.197^a ± 0.056	0.218^a ± 0.033

$V_{ss.in.}$= inulin volume of distribution, Cl_{Bin} and Cl_{BPAH}= total body clearances of inulin and PAH, respectively, FF = filtration fraction (Cl_{Bin}/Cl_{BPAH}). For each parameter, means with different superscripts are significantly different ($p < 0.05$) between the dromedary and sheep.

In the present experiment, the dromedary exhibits lower values of GFR and ERPF as compared to sheep (Table 1). The inulin clearance was significantly lower in the dromedary (1.166 ml min^{-1} kg^{-1}) than in sheep (2.22 ml min^{-1} kg^{-1}). Similarly, the clearance of PAH in the dromedary represents only 60 % of that calculated for sheep. However, the filtration fraction (FF) was significantly different between the two ruminant species.

The inulin space or volume of distribution is commonly used as an indirect measure of extracellular water volume (Hix *et al*, 1959). The apparent volume of distribution ($V_{ss.in.}$) found in the present study (about 13% of body weight) was similar for the dromedary and sheep.

This experiment had shown that the single injection technique might be a valid alternative to the constant-infusion technique for renal function assessment in the dromedary in reason of its simplicity and convenience.

The results of the present study suggested that marked differences between dromedaries and sheep will be observed in the elimination rate of drugs excreted mainly by the kidney. Such assumption has already been confirmed for benzylpenicillin (Oukessou *et al,* 1990).

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