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^{99m}Tc-APROTININ UPTAKE TEST AND SEPARATE KIDNEY FUNCTION

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Introduction

The renal agent ^{99m}Tc-Aprotinin (TcA) has been reported to offer some advantages in comparison with ^{99m}Tc-DMSA. This paper correlates net kidney uptake of TcA with effective renal plasma flow and glomerular filtration rate. Satisfactory correlations are found even if the quantitative scan is carried out only 90 minutes after injection.

The TcA uptake test we propose seems to be a feasible indicator of separate kidney function even in patients with very advanced renal failure when the role of other nuclear tracers such as ^{99m}Tc-DMSA seem to be of limited value. The test is associated with a low radiation dose, is easy and fast to perform and can be employed in outpatients.

Methods

Like other light chain proteins, Aprotinin (molecular weight 6500) is filtered through the glomerulus, taken up by the tubular cells and in part excreted in the urine as degradation products. As ^{99m}Tc labelling does not alter these properties and provides a feasible indicator of renal parenchyma [1,2] we have tried a correlation between separate net kidney uptake of ^{99m}Tc-Aprotinin (TcA) with other kidney function parameters employing nuclear techniques: separate effective renal plasma flow (ERPF, ^{131}I-OIH clearance rates, Meldolesi's method) [3] and glomerular filtration rates (GFR, ^{99m}Tc-DTPA, Gates' method) [4]. After intravenous injection of 110–180MBq of TcA (Renocis, Sorin Biomedica) separate net kidney uptake was calculated according to the method we previously proposed [2] employing a LFOV camera linked to a data processor.

Results were expressed as percentage of the injected dose for each kidney.

Results

Initially a correlation with effective renal plasma flow was attempted at various times after TcA injection (90, 180, 360 minutes) in the same subjects, while correlation with glomerular filtration rate was obtained in a further group of patients 90 minutes post-injection only. In 20 patients with renal failure a comparison with ^{99m}Tc-DMSA was also attempted six hours after injection. The results we obtained are shown in Table I. The correlation with effective

TABLE I. Correlation between cortical agent separate net kidney uptake with effective renal plasma flow (ERPF) and glomerular filtration rate (GFR)

Time p.i. (minutes)	Number (kidneys)	X	Y	a+bx	r	p<
90	202*	TcA	ERPF	4.04+0.097x	0.8145	0.001
180	202*	TcA	ERPF	6.01+0.116x	0.7953	0.001
360	202*	TcA	ERPF	8.47+0.120x	0.7797	0.001
90	32†*	TcA	ERPF	0.80+0.44x	0.5750	0.001
180	32†*	TcA	ERPF	1.13+0.055x	0.5487	0.001
360	32†*	TcA	ERPF	2.10+0.065x	0.4952	0.01
360	40	TcA	ERPF	0.68+0.12x	0.7255	0.001
360	40	DMSA	ERPF	−0.89+0.09x	0.6108	0.001
90	309	TcA	ERPF	6.59+0.078x	0.7224	0.001
90	98	TcA	GFR	6.00+0.288x	0.7206	0.001
90	45**	TcA	GFR	6.90+0.366x	0.6219	0.001

* The same subjects were studied at different times post-injection

† Patients with chronic renal failure

** Children under 14 years

p.i.=post-injection

renal plasma flow is highly significant at any time post-injection, but there is a slight deterioration of 'r' with increasing time post-injection and this is more pronounced if we consider patients with chronic renal failure separately. Probably this behaviour is related to the fact that early scans better reflect tracer arrival to the kidney while late scans are more related to the tubular handling of TcA. When TcA and DMSA are compared, although the level of significance is about the same, TcA values are less scattered. The regression line and the correlation remains the same even if we consider patients with very advanced renal failure.

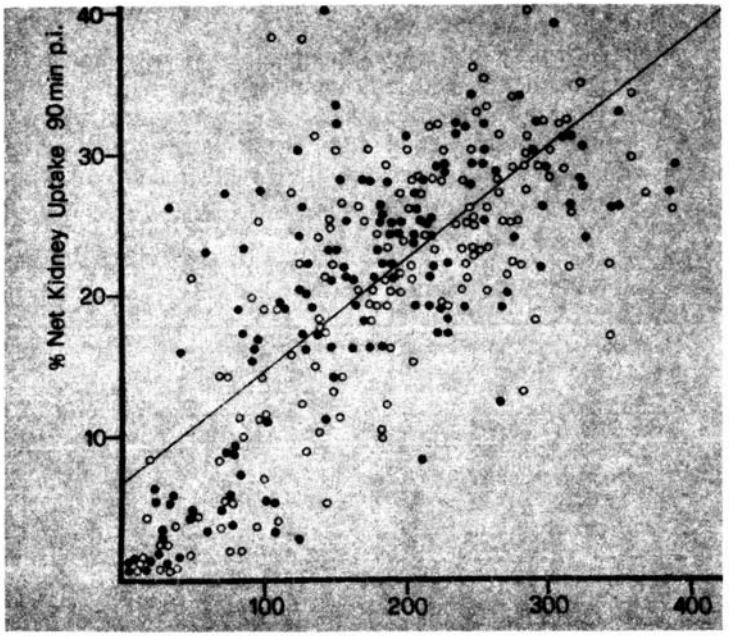

Figure 1. Correlation between separate effective renal plasma flows (x axis, ml/min) and TcA percentage uptake 90 minutes post-injection in 159 patients (309 kidneys). r=0.72, y=6.59+0.078x, $p \leq 0.001$. Solid and open circles indicate left and right kidneys respectively

These results were confirmed in a further 159 patients with various degrees of renal function studied 90 minutes post-injection (Figure 1).

Discussion

Since the first step in the renal handling of TcA is glomerular filtration, the glomerular filtration rate values too show a satisfactory correlation with the TcA uptake and this correlation was further confirmed in a paediatric group referred for urological problems (reflux, obstruction).

Probably the correlations reported should be better represented with a sigmoid curve instead of a straight line, in this way the intercept on the y axis would better approximate to the zero value. In comparison with other cortical agents, TcA offers some advantages [2] which can be summarized as follows: 1) higher kidney uptake, up to 13 times, in comparison with DMSA; 2) faster blood clearance; 3) lower urine excretion. These tracer properties allow the detection of residual functioning parenchyma (Figure 2) even in the case of very advanced renal failure. On the other hand renal TcA handling is quite complex and it is the result of different mechanisms such as plasma flow, glomerular filtration, tubular cell uptake and metabolism. Measurement of the net

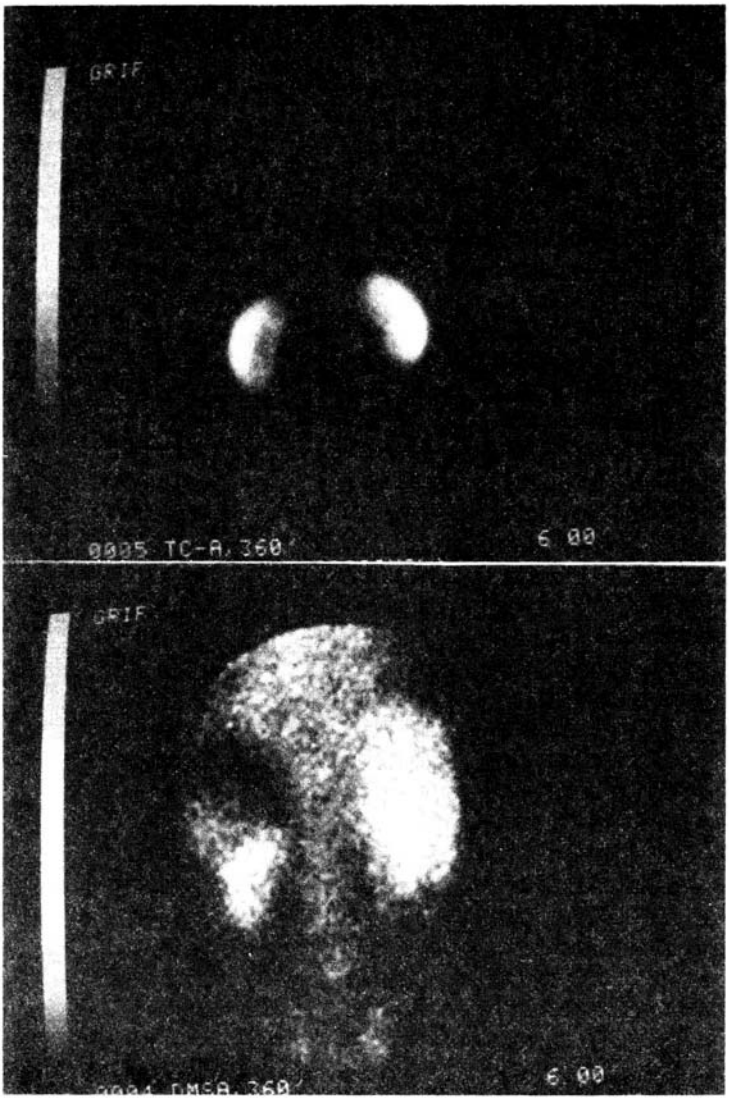

Figure 2. Renal scan in the PA view obtained in a subject with advanced renal failure six hours after intravenous injection of TcA (upper) and DMSA (lower) respectively

TcA uptake reflects the amount and the integrity of the nephron units. Taking into account the good correlation with effective renal plasma flow and glomerular filtration rate, the TcA uptake test seems to be a feasible indicator of separate kidney function and should be of value in the decision-making process and better than the measurement of a single functional parameter such as effective renal plasma flow or glomerular filtration rate especially in the case

where the filtration fraction is altered. In addition, since the test requires only about 15 minutes of imaging time and a quantitative scan is possible 90 minutes post-injection, it can easily be performed on an outpatient basis.

References

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