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DTPA renal scan assessment of renal allograft dysfunction in rats

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The precise cause of allograft dysfunction after renal transplantation often cannot be established by non-invasive means. In clinical practice, radionuclide scans form an integral part of the clinician's armamentarium in the assessment of these patients [1, 2]. Unfortunately, in the clinical setting more than one pathological process may be responsible for the impaired function, making it difficult to correlate the scan appearances with the pathology. In this study in rats we compared the renal DTPA scan appearances of the various pathological processes which may cause renal allograft dysfunction in the immediate post-transplant period.

Key words: Renal transplantation in rats – Kidney dysfunction in rats – DTPA renal scan

Methods

Male Long Evans rats weighing 300–350 g were anaesthetized with ketamine and were assigned to the treatment groups shown below. Animals were subjected to renal transplantation using standard microsurgical techniques to simulate acute rejection. For acute tubular necrosis (ATN) the kidney was rendered ischaemic by clamping the renal artery for 40 min. For cyclosporine toxicity the animals were given a single 10 mg/kg intravenous injection of cyclosporine. Ureteric obstruction and a urine leak involved ligation and division of the ureter, respectively.

The treatment groups were as follows:

Group 1 – Orthotopic transplantation of the left kidney. Normal right kidney ($n = 4$).
Group 2 – Ischaemic injury of the right kidney. Normal left kidney ($n = 4$).
Group 3 – Orthotopic transplantation of the left kidney. Ischaemic injury of the right kidney ($n = 4$).
Group 4 – Cyclosporine toxicity ($n = 4$).
Group 5 – Ureteric obstruction ($n = 2$).
Group 6 – Urine leak ($n = 2$).

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Renal DTPA scans were performed serially during the first postoperative week. Dynamic acquisitions were obtained on a gamma camera after the intravenous administration of 80–100 MBq of Tc-99m diethylylene triamine pentaacetic acid (DTPA). The renograms were reviewed and the perfusion and function of the kidneys assessed, as indicated by the uptake of the radionuclide and the clearance of the radionuclide, respectively.

Results

The initial renal DTPA scans of the transplanted left kidneys in group 1 showed decreased perfusion and decreased or impaired function when compared with the normal right kidney. Subsequent scans showed further deterioration in the perfusion and function of the left kidney. In group 2 the scans of the ischaemically injured right kidneys demonstrated normal perfusion but impaired function. In the subsequent renograms the perfusion and function reverted to normal. The renal DTPA scans of the animals in group 3, which had a transplanted left kidney and an ischaemically injured right kidney, confirmed the above findings.

The renographic appearances of the kidneys with cyclosporine toxicity in group 4 demonstrated decreased perfusion and impaired function initially. On subsequent scans the perfusion and function were normal. In group 5 the kidneys with ureteric obstruction demonstrated decreased perfusion and impaired function on the initial and subseqeunt renal DTPA scans. The perfusion and function of the kidneys with the urine leak in group 6 were normal according to the DTPA scan. However, extravasation of DTPA was demonstrated.

The renographic findings are summarized in Table 1.

Discussion

The common causes of allograft dysfunction after renal transplantation include acute rejection, ATN, cyclosporine toxicity, and technical complications such as urine leak and ureteric obstruction. Often, invasive methods,

Table 1. Summary of the renal DTPA scan appearances for acute rejection, ATN, Cyclosporine toxicity, ureteric obstruction and urine leak

	Initial scan		Subsequent scan	
	Perfusion	Function	Perfusion	Function
Acute rejection	↓	↓	↓↓	↓↓
ATN	N	↓	N	N
Cyclosporine toxicity	↓	↓	N	N
Urine leak	N	N extravasation	N	N
Ureteric obstruction	↓	↓	↓	↓

N, normal

such as a renal biopsy or angiography, are required to determine the precise cause of the abnormal renal function. The use of radionuclide scans after renal transplantation in patients has been documented previously [1]. Unfortunately, because of the overlap of the various pathological processess which can affect the graft after transplantation, it is difficult to determine the exact scan appearance of the individual pathology so that clinical decisions after renal transplantation are almost never based entirely upon the renal scan appearance. In this study, we created each pathological process which could cause renal dysfunction after renal transplantation and investigated the renal DTPA scan appearances.

In the normal kidney there was rapid uptake of the radionuclide, representing perfusion of the kidney. This was followed by rapid clearance of the radionuclide, representing handling by glomerular filtration and the excretory function of the kidney. Non-functioning kidneys or segmental infarctions did not take up the DTPA and were visualized on the scan as cold lesions.

As demonstrated in this study, the renal scan findings in ATN were good perfusion and poor function with a tendency to revert to normality in subsequent scans. In acute rejection the renal scan showed poor perfusion and poor function which continued to deteriorate in later scans. The initial renal scan appearances of cyclosporine toxicity were similar to acute rejection, but with cyclosporine toxicity there was a trend towards improvement in subsequent scans. Extravasation of contrast on renal scan was indicative of a urine leak. Ureteric obstruction had similar renographic appearances to acute rejection. In the clinical situation an ultrasound would easily distinguish between these two.

We believe that the DTPA renal scan, especially when used serially, is a useful non-invasive investigation in the assessment of allograft dysfunction after renal transplantation. When used in combination with the clinical findings and simple tests, such as ultrasound, the cause of the impaired function can be determined without having to resort to invasive investigations such as a renal biopsy.

References

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