Acute-phase Kidney Transplants Show Early Peak Appearance in Tc-99m DTPA Renogram

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Summary: Kidney transplants have been evaluated using a radionuclide technique to determine perfusion index (PI), mean transit time (MTT), and the parameters in renogram curve (Tmax, T1/2, and T2/3). The values for Tmax, T1/2, and T2/3 were also determined in normal volunteers. The results indicated that the Tmax value was less than 2 minutes, one week after transplantation. The other data were within normal limits. The appearance of Tmax was very early. The early time activity curve (TAC) was quite similar to the blood disappearance curve, TAC did not have the functional-phase, so-called, 2nd-phase. These data suggested that there could be an abnormality of the renal circulation in the transplanted kidney. The suggestion offers the new finding in a field of renal transplantation using radionuclide technique.

Key words: Radionuclide renoscintigraphy — Tc-99m DTPA — kidney transplants — renogram curve — Tmax

Introduction

Cadaveric renal transplantation has truly been a landmark in the treatment of end stage renal disease. Continuing refinements of kidney preservation, surgical technique, tissue typing and immunosuppression have made this approach the treatment of choice for the majority of patients—within the limits imposed by organ availability.

Radionuclide studies have represented a major advance in the functional evaluation of the transplanted kidney (Anaise et al. 1986; O'Relly et al. 1986). This is particularly true in the immediate peri-operative period, during which the clinical and biochemical parameters used to evaluate renal function may be misleading. Although a number of studies (intravenous urography, ultrasonography, X-CT/MRI) can provide important anatomic information, radionuclide studies provide unique functional data; in addition, these studies are noninvasive and may be repeated serially at minimal risk to the patients.

The present report describes the repeated application of Tc-99m DTPA in two peri-transplant patients.

Methods

Two patients with kidney transplants underwent renoscintigraphic studies 5
times. The first renoscintigraphic study was performed about one week after the transplantation. The two patients were a 29-year-old male (case 1) and a 31-year-old male (case 2). The donors, in cases 1 and 2, were the patients' mother and father, respectively.

Thirty minutes before the examination, each patient urinated and drank 300 ml of water. Subsequently, Tc-99m (Sn) DTPA was administered to the recipients. The radionuclide data was acquired with anger camera equipped with all purpose parallel hole collimator using a 20% window. The data were recorded in a dedicated computer system.

Data collection
The patient was placed in the supine position. A gamma camera was positioned over the patient's pelvis including both the transplanted kidney and the bladder. The right upper arm was lifted to a 90 angle in a slightly valgus position, and Tc-99m DTPA (555 MBq) was rapidly injected intravenously as a bolus, at a rate of approximately 2 ml/sec. Scintigrams were acquired using a total of 147 frames

Fig. 1. Mean transit time (MTT) in case 1 is demonstrated.

Fig. 2. RI angiography, sequential images (5, 10, 15, 20, 25, and 30), and renogram curve taken one week after transplantation in case 1,
in 30-minutes beginning immediately after the injection. A 64×64 pixel matrix was taken at a rate of 1 frame/sec for the first minute and at 1 frame/20 seconds for the remaining 29 minutes. The acquisition data were stored in the computer.

The level of cut off was at 0%.

Perfusion index (PI)

Based on to Hilson’s method (Hilson et al. 1978), ROI was set at the transplanted kidney and the peripheral iliac artery. The time activity curve (TAC) of the perfusion phase was determined after the background subtraction.

Mean transit time (MTT)

Fig. 2 demonstrates the mean transit time by Sagawa’s technique (Sagawa, 1980) based on Oldendorf method (Oldendorf, 1962). Fig. 1 illustrates case 1, one week following the kidney transplant.

Analysis of renogram curve

The parameters (Tmax, T1/2, and T2/3) were calculated from the renogram with ROI set over the entire kidney. Mean perfusion index (PI), mean transit time (MTT), mean Tmax, mean T1/2, and mean T2/3 as the normal value are demonstrated as follows;

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>PI</td>
<td>&lt;150 (sec)</td>
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<tr>
<td>MTT</td>
<td>&lt;10 (sec)</td>
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<tr>
<td>Tmax</td>
<td>2.86 ± 0.53 min (N=18)</td>
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<tr>
<td>T1/2</td>
<td>9.6 ± 1.86 min (N=18)</td>
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<tr>
<td>T2/3</td>
<td>5.96 ± 1.19 min (N=18)</td>
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Results

Table 1 demonstrates the data acquired from the transplanted kidneys. PI and MTT in cases 1 and 2 were both within the normal range.

One week after renal transplantation (Fig. 2, case 1):

The radionuclide angiography demonstrated that the transplanted renal blood flow in the two patients were low in comparison to the background. The sequential images after 5 and 30 minutes were not quite the same, and both were dysfunctional images. However, the bladder was imaged gradually accumulation of urine. Overall, the radionuclide passage in the transplanted kidney may be normal. In case 1, the heart pooling image was still seen 39 minutes.

The analysis in renogram curves showed that the RI uptake and excretion in the transplanted kidney were very fast (see Table 1). The Tmax for case 1 was 1.00 minutes and T2/3 was 2.66 min. In

<table>
<thead>
<tr>
<th>Table 1: The renal transplantation data</th>
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<tr>
<td>Case</td>
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the case 2, the \( T_{\text{max}} \) was 1.33 min and \( T_{2/3} \) was 1.66 min. The excretion time was 4 or 5 minutes following the injection of RI. The renogram curve during the excretion phase, especially in case 1, was at the nadir, at which time the creatinine values were 1.1 mg/dl in case 1 and 2.2 mg/dl in case 2.

Over one month after renal transplantation (Fig. 3, case 1):

The radionuclide angiography demonstrated good renal blood flow in both cases. The sequential images showed a slight delay in the excretion phase, but RI uptake and passage were good. On the renogram curves, the excretion phase indicated a slow delay, but the \( T_{\text{max}} \) was normal as \( T_{\text{max}} \) (case 1) was 4.00 minutes and \( T_{\text{max}} \) (case 2) was 3.00 minutes. The \( T_{2/3} \) (case 2) was 8.33 minutes (see table 1).

In case 2, the further renoscintigraphic study performed 3 month after transplantation was normal see (table 1).

Discussion

The goal of radionuclide studies during kidney transplantations are to have an early and discriminate diagnosis to prevent complications which include acute tubular necrosis, acute rejection, and urinoma. Also, the radionuclide investigations have the advantages of being non-invasive and may be repeated frequently.

The two transplants examined in the present study were donated by family members. The follow up studies yielded good results. The MTT and PI were normal.
RI angiography

The renal blood flow in the transplanted kidney was maintained, as determined by radionuclide angiography.

Sequential image

On seven days following transplantation, the renal image demonstrated less accumulation. Further, the dysfunction in renal parenchyma was suggested.

Analysis of renogram curve

The Tmax for the 2 cases, which is a classical parameter from the renogram curve, were within 2 minutes of each other during the first renoscintigraphic study after transplantation. The Tmax of normal volunteers was $2.86 \pm 0.53$ minutes ($N=18$), as previously described (Ishibashi, 1987). With respect to the Tmax value in the 2 cases, it may be considered to be early appearance. It is also difficult to consider the sequential images as a good renal clearances. However, the excretion phase demonstrated nadir curve. The value of creatinine was slightly higher (1.1 mg/dl).

For this reason, it may be difficult to find out the reasons for the early peak appearance of Tmax. Nonetheless, it can be summarized that the tracer quickly passed early through the transplanted kidney.

The representative phenomenon focused: (1) since the transplanted kidney was implanted in the pelvis, the velocity of renal blood flow in the transplanted kidney was faster. (2) in this environment, allasotonic contraction of efferent arterioles could occur and could be caused by the renal transplantation.

The radionuclide study, evaluating the transplanted kidney, has been numerously reported. It must be emphasized however that no previous investigation addressed the early peak appearance of Tmax in renogram, although this parameter is based on classical analysis of renoscintigraphic data.

References


