Renography and Scintiphography with $^{131}$I Hippuran and $^{99m}$TcO$_4$ in Renal Transplantation

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The use of radioisotopes has proved particularly useful in the diagnosis of functional disorders in transplanted kidneys. In 1964 the first studies on renographic changes relative to rejection appeared (Loken et al., 1964). Later, renography proved useful in the differential diagnosis of acute tubular necrosis, rejection, urinary tract obstruction and finally in the assessment of the function of the transplanted kidney over a longer period of time (Magnusson et al., 1966; Sharpe et al., 1966). Our work (Confortini et al., 1969) with radioisotopes was strengthened by the use of the gamma camera in association of $^{99m}$TcO$_4^-$ and $^{131}$I hippuran.

METHODS

The gamma scintillation camera (referred to here as the gamma camera) employs a solid sodium iodide scintillation crystal of 11.5 in (29 cm) diameter and 0.5 in (1.25 cm) thick, viewed by an array of multiplier phototubes. An oscilloscope reproduces the scintillations as the scintillation image (referred to here as a scintiphograph). This permits constant visual monitoring of the passage of radioisotope through the explored region. The images are recorded on Polaroid film. With sequential scintiphographs one may study the organ morphology and function.

After injection into the cubital vein of 10 mCi of $^{99m}$TcO$_4^-$ in a volume of two ml or less, distribution and diffusion of the bolus of radioactivity within the abdominal aorta, iliac vessels, and transplanted kidney is recorded on Polaroid film, every 7 seconds with 7 seconds of exposure. The small whole body radiation dose allows frequent repetition of the test. After the injection of 250 µCi of $^{131}$I hippuran into the cubital vein, serial Polaroid photographs demonstrate the passage of radioisotope through the parenchyma and pelvis of the transplanted kidney into the bladder, from 0 to 40 minutes; 90 seconds of exposure are used for every scintiphograph.
RESULTS AND DISCUSSION

The oligo-anuric period

All the patients were studied with the $^{131}$I hippurain renogram from the first day after transplantation. During this period it is extremely important to have knowledge of the flow in the major vessels of the transplant, especially if oliguria is present. The renograms were chiefly represented by accumulation curves with the presence of an uptake phase.

According to the results of others, these renographic curves could be related to acute tubular necrosis in transplanted cadaver kidneys with ischaemia lasting from 20 to 25 minutes. Progress was followed by renography until diuresis and recovery of kidney function occurred; this period varied from one to 23 days after transplantation.

During the period of anuria, the renograms (Figure 1) showed only the uptake phase with progressive improvement of 'secretory activity.' After the recovery of kidney function, the renograms showed in addition an excretory phase.

Figure 1. Renograms of transplanted kidney from a cadaver, illustrating renographic restitution after acute tubular necrosis. (Read from top to bottom) Initially (8/6/69) only uptake phase is seen. One month after transplantation, (13/7/69) an excretion phase is also visible. After 2 and 3 months (27/7/69 and 3/8/69) renogram and cystogram had a normal appearance. (Renograms read from right to left)
CASE REPORTS

Acute rejection

In one patient rejection occurred three days after transplantation and com-

plicated the study of recovery from the effects of ischaemia which in this
case was less than 20 minutes. The patient was repeatedly studied with
renography and the gamma camera, using $^{131}$I hippuran.

Figure 2 shows renograms taken up to two months after transplantation.
On the first day (27/2/70) the patient had a parenchymal curve with a good
uptake phase and some initial excretion. After 30 minutes the isotope had
accumulated in the urine from the ureteric catheter. Four days after trans-
plantation the patient had a decrease in urinary output, and clinical symptoms
of acute rejection. Renography (14/3/70) showed impaired uptake capacity
and no excretion phase, with a very slow accumulation curve (Figure 2). The
gamma camera scintiphotographs with $^{99m}$TcO$_4^-$ showed vascularisation in
the transplanted kidney and transfemoral aortography demonstrated good
flow in the major renal vessels and in the intraparenchymal vessels.

Figure 2. Renographic development in acute rejection. (Read from right to left)
Figure 3. G-Camera with $^{131}$I hippuran in transplanted kidney. Persistence of high radioactivity in the kidney, after 60 minutes, without tendency to an excretion phase.

We therefore continued immunosuppressive and steroid therapy. Gamma camera pictures and renography with $^{131}$I hippuran produced, in this period of oligo-anuria, accumulation curves without any tendency to an excretion phase (Figure 3). In addition the gamma camera scintiphotographs failed to show any concentration of hippuran in the renal pelvis. This case demonstrates, therefore, a pattern of parenchymal damage.

The transplanted kidney recovered good function after two months, and the recovery from the acute rejection became complete only after eight months. By this time, renography with $^{131}$I hippuran showed the beginning of an excretion phase. The gamma camera demonstrated early passage through parenchyma and pelvis with good accumulation of radioactivity in the bladder after 15 minutes. Persistent hypertension in this patient led us to perform a bilateral recipient nephrectomy one year after transplantation. Renography in this period was normal (Figure 4). Endogenous creatinine clearance was between 40 and 50 ml/min at this time.

Figure 4. Renogram in patient one year after transplantation. The curve is normal.
Figure 5. The renogram in ureteric obstruction. Top: (19/11/69) 3 days after transplantation, good uptake phase. Next: (12/1/70) persistence of accumulation curve, two months later, still present at (18/3/70) with poor vesical accumulation.
6/5/70 - post operation; 26/8/70 - normal tracing
Ureteric obstruction

Renography and gamma camera studies using $^{131}$I hippuran were particularly useful in the diagnosis of ureteric obstruction at the site of the ureteroneocystostomy. In this patient we noted persistence of the accumulation curve after functional recovery of the transplanted kidney. In the bladder there was no accumulation of isotope. After correction of the ureteric obstruction there was improvement of the clinical and renographic data (Figure 5). The gamma camera with $^{131}$I hippuran showed rapid secretory and excretory activity of isotope, and after 30 minutes good accumulation in the bladder.

Hyperacute rejection

In another case we used the gamma camera with $^{99m}$TcO$_4^-$ to demonstrate hyperacute rejection during the second day after transplantation (Figure 6). This study was done after renography had failed to show any radioactivity in the transplanted kidney. The scintiphotograph demonstrated no perfusion of the transplanted kidney. Aortography showed absence of vascularisation in the kidney parenchyma, and demonstrated good flow at the site of arterial anastomosis.

![Figure 6. Hyperacute rejection Gamma Camera with $^{99m}$TcO$_4^-$ in transplanted kidney, 2 days after transplantation. Perfusion of aorta, iliac arteries. No perfusion of transplanted kidney. The unvascularised kidney appears as a black shadow upon the right iliac artery](image)

SUMMARY

The use of the gamma camera using both $^{131}$I hippuran and $^{99m}$TcO$_4^-$ has been useful in the diagnosis of rejection and obstruction in transplanted kidneys. The gamma camera gives morphological, functional and vascular data on the transplanted kidney. This simple, non-invasive technique allows one to perform aortography and urography only in those cases in which these methods are indispensable.
REFERENCES


OPEN DISCUSSION

L WIBELL (Uppsala): I would like to ask you if you have carried out gamma scintigraphy on any cases of renal artery stenosis in the transplant. We have performed 100 scintigrams in a series of 30 patients, using $^{99m}$Tc Iron complex. The test was most useful in the routine follow-up of grafts and we needed to do only 10 aortograms on these 30 patients. However, twice severe renal artery stenosis was not detected by the gamma camera, one on the 8th day and one after 2 months. So far these are the only failures with gamma scintigraphy. At present, we use aortography only when artery stenosis is suspected clinically, and when an abnormal scintigram cannot be interpreted conclusively.

P MICHELESEN (Louvain, Chairman): Any other questions? Well, the problem of renal artery stenosis has been raised. I think there is one report in the literature of a transient stenosis of the renal artery, which was published from an English group. Could we ask if someone else in the audience has had the same experience? Nobody else has seen stenosis of the renal artery which later disappears spontaneously?

DAHLAGER (Copenhagen): I have done 600 renograms and used this test in patients with renal artery stenosis; on several occasions the stenosis did not show on the renogram. We also did arteriograms and even in retrospect we could not see evidence of the stenosis on the renogram.