A Method for Improving the Accuracy and Shortening the Generation Time of a Renogram Curve with the Scintillation Camera

Dan G. Pavel, Bryan R. Westerman, and James J. Conway

Northwestern Memorial Hospital and Children's Memorial Hospital, Chicago, Illinois

A method is described for recording renogram curves with a scintillation camera from regions of interest without the need for playing back the data stored on videotape. This is done by using ^{99m}Tc-DTPA for predetermination of the regions of interest and then setting the control subpanel of the scintillation camera in the appropriate way. By using this technique, one obtains reliable Hippuran curves simultaneously with the scintiphotos, and by using ^{99m}Tc-DTPA additional diagnostic information is obtained.

The production of accurate renogram curves from the scintillation camera using a videotape recorder can be of considerable clinical value but is time-consuming. The stored data are briefly replayed following the recording so that cursors may be adjusted to enclose the areas of interest. The videotape is then replayed for the entire duration of the study (20–30 min) to generate the renogram curves. What should have been a simple, rapid test becomes a tedious procedure involving excessive technologist and camera time. In addition, the final result and interpretation may be delayed for hours awaiting processing time on the camera. This methodology became unacceptable because of the increasing number of studies in our departments and with renal transplant patients in particular, on whom the final results were often requested immediately.

On the other hand, the split crystal technique was found unacceptable for the following reasons: (A) the proximity of the transplanted kidney to the bladder, making accurate separation difficult; (B) the location of ectopic urinary excretion pathways, such as ileal conduits, cutaneous ureterostomies, and urinary collection bags, or the holdup in stenotic, obstructed, or atonic ureters, presenting the same technical difficulty; and (C) the high background, especially in infants and small children, and also in decreased renal function. A solution to these recurrent problems was thus sought.

A feature of the videotape system used is that the entire camera output is recorded regardless of the status of the "areas of interest" and scaler/ratemeter controls. Consequently, the renogram curves may be generated concurrently with the tape recording, provided the areas of interest can be defined before the injection of the ^{131}I-Hippuran. This can readily be accomplished using ^{99m}Tc-DTPA, which is already an integral part of the renal study protocol in many institutions. If any additional information is desired, it can be obtained from a replay of the tape containing all of the original information.

Materials and Methods

Both departments use Searle Pho/Gamma III HP cameras, with videotape data recorder, persistence cathode-ray oscilloscope, and histocorder. A medium-energy 1,000-hole collimator was used. The histocorder accessory to the Pho/Gamma III camera is a small, special-purpose, hard-wired computer, designed to facilitate the acquisition and analysis of time-activity histogram data (Fig. 1).

Renal transplant study. The camera is positioned anteriorly to include both the kidney and bladder areas. Ten millicuries of ^{99m}Tc-DTPA is injected intravenously through a three-way stopcock connected to a butterfly-type needle. The

For reprints contact: Dan G. Pavel, Section of Nuclear Medicine, University of Illinois Hospital, 840 S. Wood, Chicago, Ill. 60612.

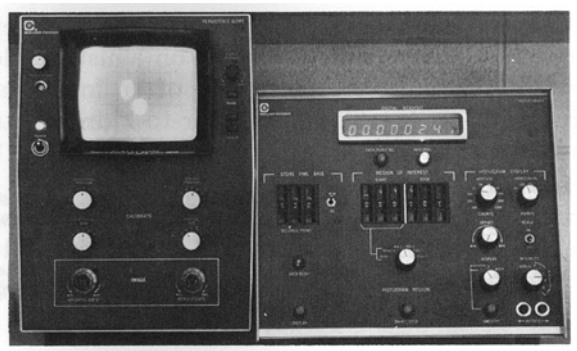

FIG. 1. Display setup including persistence oscilloscope and histocorder. Typical representation of areas of interest on persistence oscilloscope in renal transplant is shown.

catheter is then flushed with normal saline. An outline of the visualized kidney is drawn on a piece of transparent film placed over the screen of the persistence oscilloscope. An area of interest is then delineated using the appropriate controls to coincide with the outline. A second area of interest corresponding to the bladder is approximated at the beginning of the initial examination and then accurately outlined at the end of the study. The transparent piece of film is stored as a permanent pattern and will be used to establish both areas of interest on subsequent studies. For example, after the kidney is outlined with the labeled DTPA injection, the patient is positioned so that the kidney activity falls within the previously drawn outline. Thus the bladder area will be automatically established. The Polaroid camera is attached to the B oscilloscope so that a Polaroid picture can be taken while the "AREA CAL" button is briefly depressed. This will enable the superimposition of the areas of interest over the kidney and bladder image providing visual evidence of the accuracy of positioning.

Once the areas of interest are established, the control subpanel is set on "RECORD," "AREA 1/AREA 2," and "NORMAL." The histocorder and data store are activated, the ^{131}I-Hippuran is injected through the same intravenous setup in the same manner as the ^{99m}Tc-DTPA, and sequential 3-min Polaroid images from the B oscilloscope are taken. At the end of the Hippuran study, a superimposition of the areas of interest over the kidney and bladder images is obtained* and used as a final quality-control check (Fig. 2A and B).

The kidney and bladder curves from the histocorder are displayed and photographed immediately after completion of the study (Fig. 2C).

Routine renal study.† The camera is positioned posteriorly, and the sequence of events is the same as those given for the renal transplant study except that areas of interest are selected for both kidneys following the ^{99m}Tc-DTPA injection.

Discussion and Conclusions

The desirability of generating renogram curves from the scintillation camera is generally accepted. Nevertheless, there are two major problems with the usual method. First, if the curves are obtained by the "split" crystal method, their accuracy may be compromised because of the "background" or extrarenal activity contribution to the curves. This problem is accentuated in diseased kidneys with decreased function and in small children. Also, in the transplant patient, correct positioning of a "split" crystal to prevent overlap between kidney and bladder is usually difficult and may be impossible. Second, if the data have to be stored and then replayed, this more than doubles the procedure time, which becomes a serious problem of both camera and technologist availability.

The method described has the advantage of generating renogram curves without a significant increase in procedural time. Technetium-99m-DTPA is routinely used for the evaluation of renal blood supply, and for kidney and urinary tract imaging. After recording the necessary angiographic information during the first minute, the ^{99m}Tc-DPTA in the kidney can be used to determine the areas of interest. This operation requires only 2–3 min depending on the experience and skill of the technologist. The image recorded on Polaroid film by superimposing the areas of interest over the kidney images (or over the kidney and bladder) represents an accurate control and avoids

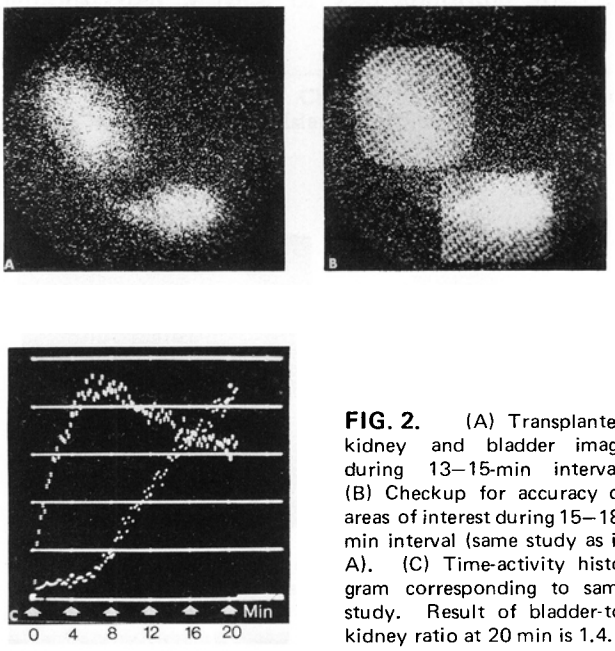

FIG. 2. (A) Transplanted kidney and bladder image during 13–15-min interval. (B) Checkup for accuracy of areas of interest during 15–18-min interval (same study as in A). (C) Time-activity histogram corresponding to same study. Result of bladder-to-kidney ratio at 20 min is 1.4.

*To speed up the procedure we sacrifice the sequence between 15 and 18 min and use it for the superimposition.

†A detailed copy of our protocol is available from the authors.

misinterpretations due to incorrect placement of areas. If there is any doubt, the magnetic videotape recording remains available and, as previously mentioned, the data from the entire camera field are stored regardless of the areas of interest selected. A new set of curves can thus be obtained with repositioned areas of interest if so desired. In our experience, this has rarely been necessary.

At the completion of the study, the curves are readily available allowing an immediate interpretation. If the curves are displayed on a histocorder, this also includes the possibility of an immediate calculation of the 20-min bladder-to-kidney ratio. These rapid results are particularly appreciated by the transplant team.

If only an analog dual-chart recorder is available, the same technique can be used but without the benefits and flexibility of the histocorder.