Technical Aspects and Pitfalls of Nuclear Cystography

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Nuclear cystography can be utilized in any nuclear medicine department that has a scintillation camera. Once the pitfalls and technical aspects are fully understood, the nuclear cystogram can be simply and accurately performed. Potential pitfalls include: patient apprehension; introducing the radionuclide into the saline bottle instead of the catheter; radionuclide interference from previous studies; unsatisfactory positioning; and improper removal of the catheter.

Among the many imaging procedures available to nuclear medicine, the nuclear cystogram is a proven and useful diagnostic procedure for detecting vesicoureteral reflux (*1-3*). In 1959 Winter introduced the nuclear cystogram that used either I-131 rose bengal or I-131 Diodrast (*1*). The procedure involved instilling the radionuclide directly into the bladder and recording the counts from the kidneys with a scintillation detector. In 1963 Dodge proposed an indirect method (*2*), which employed I-131 hippuran injected intravenously and counts taken over the kidneys; any increase in counts while the patient voided was diagnosed as reflux. Conway et al. in 1974 investigated direct and indirect radionuclide cystography (*3*). The indirect method using the Tc-99m labeled compounds proved the ease and sensitivity of the nuclear cystogram (Fig.1).

Early detection of vesicoureteral reflux is extremely important to the urologist. Its diagnosis and treatment have been effective in interrupting the progression of chronic pyelonephritis and preventing subsequent episodes of acute pyelonephritis in children (*4*). The cause of vesicoureteral reflux depends on these factors: (a) length of the intravesical portion of the ureter, (b) diameter of the intravesical ureter (submucosal tunnel), (c) ratio of the length to the width in the intravesical ureter, (d) pliability of the roof of the intravesical ureter, which functions as a flap valve, and (e) integrity of that portion of the detrusor that underlies and buttresses the intravesical ureter (*5*) (Fig.2).

Materials and Methods

The nuclear cystogram uses the direct instillation of radionuclide into the bladder through a catheter that is connected to an intravenous infusion set by a plastic adapter. An i.v. solution of 500 cc of normal saline is connected to the intravenous set. One mCi of [^{99m}Tc]pertechnetate is injected into the intravenous tubing close to the catheter (Fig. 3). Following the administration of 1 mCi of Tc-99m, the saline is allowed to fill the bladder. The saline will flow freely until the bladder is full. Pressure from a normally distended bladder is greater

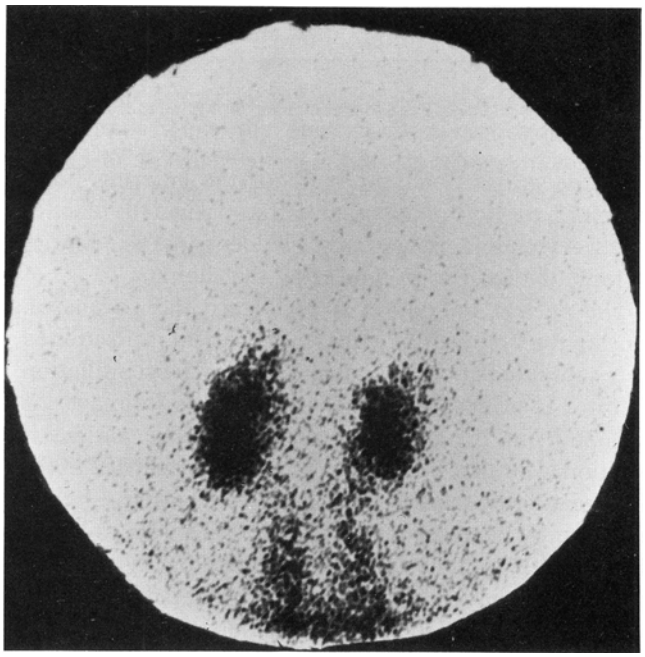

FIG. 1. Nuclear cystogram performed on a 2-year-old girl shows bilateral reflux.

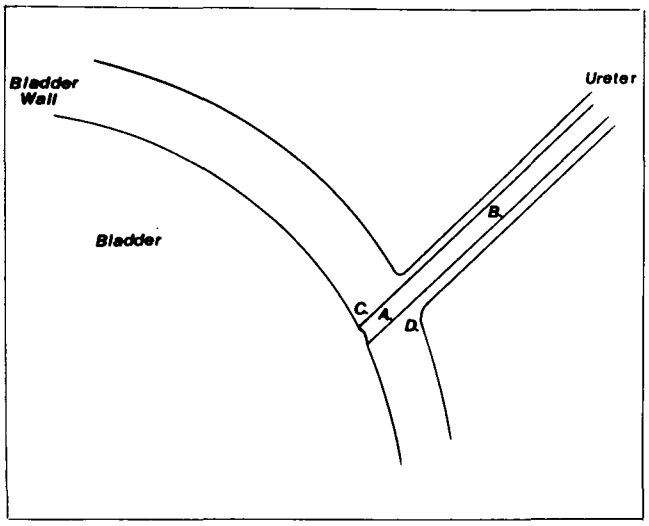

FIG. 2. Diagram of a ureter entering the bladder shows (A) submucosal tunnel, (B) intravesical ureter, (C) flap valve, and (D) detrusor buttress.

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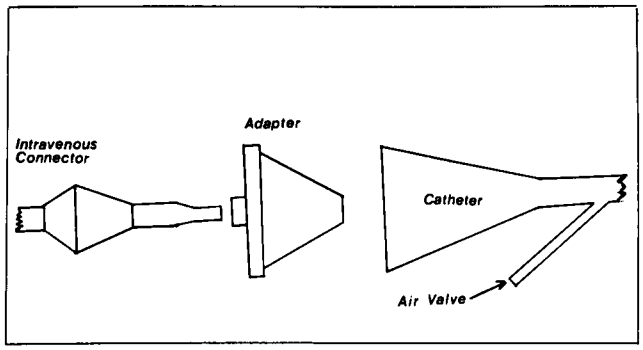

FIG. 3. Diagram shows the connection of the intravenous set-up and the patient's catheter.

than the gravitational pressure of the entering fluid; therefore, the flow of the saline will stop when the bladder is full. A technologist can cause bladder damage if he tries to force the fluid in by squeezing the tubing.

The nuclear cystogram is performed in two phases. During the first or filling phase, the patient is positioned in a supine position on a lucite table. The scintillation detector is placed beneath the table so as to image the patient from the posterior projection. The patient is positioned so that half of the bladder is visualized at the bottom of the scintiphotos. This can be done before injection by using a marker source of Tc-99m to locate the patient's symphysis pubis, or immediately after the radionuclide has entered the patient's bladder at the start of the study. While the patient's bladder fills, the volume of normal saline that has entered the bladder is recorded.

Once the patient's bladder is full, the second or voiding phase is begun. For the remainder of the test the patient sits upright on a bedpan. The scintillation detector is placed behind the patient's back and the bladder is positioned at the bottom of the detector. The patient's catheter is removed and the patient voids. Scintiphotos are taken before the catheter is removed, continually throughout the time the patient is voiding, and after the patient has finished voiding. The technologist should wear gloves at all times during the study.

We studied 62 patients, the majority of whom were adults. Of these, only three were positive for vesicoureteral reflux; all three were children. This is due to the fact that vesicoureteral reflux occurs predominantly in children (*4*).

Discussion

The nuclear cystogram is a relatively simple procedure, but there are several potential pitfalls that may be encountered. These are (a) patient apprehension, (b) introducing the radionuclide into the saline bottle instead of the catheter, (c) radionuclide interference from previous studies, (d) unsatisfactory positioning, and (e) improper removal of the catheter.

Frequently the patient is aprehensive about his bladder being injured during the nuclear cystogram, especially during the filling phase.The best way to make the patient feel at ease is to explain the entire procedure prior to the test. The technologist should emphasize the fact that even though some bladder discomfort will be involved, the technique is safe and some pain is associated with distention. The patient may also be apprehensive about

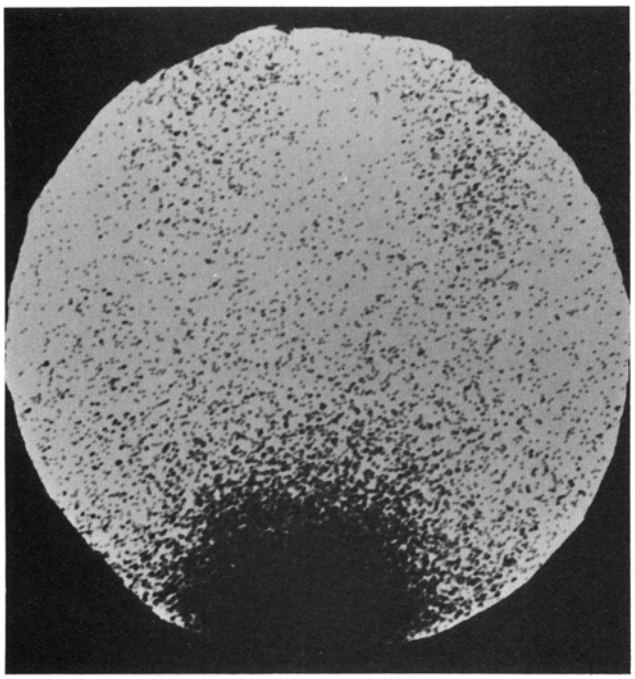

FIG. 4. Nuclear cystogram shows radionuclide interference from Tc-99m DTPA. The Tc-99m DTPA is residual activity from a renal scan performed one day before the nuclear cystogram.

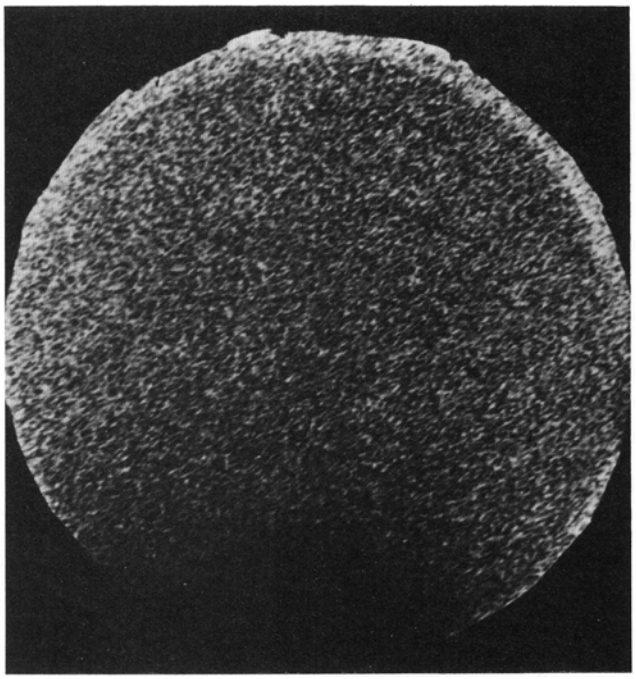

FIG. 5. Nuclear cystogram shows radionuclide interference from gallium-67; the patient was injected with gallium-67 three days before the nuclear cystogram.

voiding in front of the technologist—this problem can be minimized by having male technologists perform scans on male patients and female technologists perform scans on female patients.

Introducing the radionuclide into the bladder can be done in two ways. The first is to inject the radionuclide into the saline bottle; the second is to inject the radionuclide into the intravenous tubing close to the catheter connection. The latter is preferred because it allows the radionuclide to enter the bladder as a bolus. If the bladder capacity is small or if a spasm occurs, all of the fluid will not enter the bladder. Thus if the radionuclide is injected into the bottle, some of it will not reach the bladder. The second method allows a higher percentage of the radionuclide to be available to visualize the reflux, if it is present.

In all studies in which radionuclides are involved, radionuclide interference from previous studies can present a problem. In recent years, urologists have begun to use many nuclear procedures to aid in diagnosis of genitourinary disorders. Occasionally a higher energy radionuclide is used first and then at a later time a decision is made to order a nuclear cystogram. The technologist should make a special effort to notify the physician that the cystogram may not be useful because of radionuclide interference from a previous study. The physician should also be made aware that the cystogram should be performed first (Figs. 4 and 5).

Proper positioning is important in any study. When performing the nuclear cystogram, the technologist should remember that as much of the kidneys and ureters as possible must be visualized with the bladder. The method is to position approximately half of the bladder within the field of view of the camera. If desired, separate views of the bladder can be obtained.

During the cystogram, when the technologist (wearing gloves at all times) removes the patient's catheter he must take care both to prevent contamination of the department, and to ensure the comfort of the patient. After the filling phase is complete, the catheter's air valve must be cut to decompress the balloon at the end of the catheter that is in the bladder. The patient should strain as in voiding while the technologist removes the catheter. This may help in the removal of the catheter, which should never be forcibly withdrawn.

These pitfalls and technical aspects are an integral part of this scanning procedure. Once the technologist understands them, the nuclear cystogram can be performed in any nuclear medicine department that has a scintillation camera.

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