Role of $^{99m}$Tc-IDA Cholescintigraphy in Evaluating Biliary Tract Disorders

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Abstract. Technetium-99m IDA cholescintigraphy has provided a new, noninvasive means of visualizing biliary tract function. It has become the procedure of choice in patients with suspected acute cholecystitis because of its ability to most accurately detect functional obstruction or patency of the cystic duct as opposed to ultrasound's ability to detect only anatomic changes such as the presence of calculi or a thickened gallbladder wall. These latter findings are more important in establishing the diagnosis of chronic cholecystitis where ultrasound shares a position of prime importance with the oral cholecystogram. Tc-99m IDA cholescintigraphy has also been particularly useful in evaluating bile leaks, biliary-enteric anastomosis patency and the post-cholecystectomy patient with recurrent pain. In the patient with cholestasis, ultrasound is usually the procedure of choice since it establishes whether or not ductal dilatation is present and frequently can determine the cause of obstruction. Cholescintigraphy has played an ancillary role in many cases by demonstrating the level of partial obstruction, but it does not have the anatomic resolution to visualize the cause of obstruction. Occasion ally, in the evaluation of cholestasis, cholescintigraphy has proven to be the only modality which has identified the presence of acute common duct obstruction or localized intrahepatic ductal obstruction. All in all, Tc-99m IDA cholescintigraphy has had a dramatic impact upon hepatobiliary diagnosis.

Key words: Cholescintigraphy - Acute cholecystitis - Technetium-99m IDA - Biliary tract.

Visualization of the hepatobiliary system in acute and chronic cholecystitis, cholestasis, and the postoperative patient has remained a challenge to the radiologist and clinician, as evidenced by the multitude of procedures currently in use. With the advent of ultrasonography and computed tomography, and the ready availability of the older procedures such as oral cholecystography, intravenous cholangiography, transhepatic cholangiography, and endoscopic retrograde pancreaticoduodenography, it is difficult for most to conceive of a potential role for a nuclear medicine imaging procedure. However, during the same period of time that ultrasonography and computerized tomography were coming of age and being advocated as the primary modalities for the evaluation of hepatobiliary disorders, a promising new group of technetium-99m-labeled radionuclides were being developed - the iminodiacetic derivatives [1, 2]. We have now studied over 1500 patients with Tc-99m IDA cholescintigraphy and we have found this functional examination to be the diagnostic procedure of choice in certain specific clinical situations.

$^{99m}$Tc-IDA analogs, including HIDA (dimethyl iminodiacetic acid, Merck-Frosst Laboratories, Dorval, Quebec), PIPIDA (paraisopropyl iminodiacetic acid, Diagnostic Isotopes Corp., Upper Saddle River,
Fig. 2. Normal $^{99m}$Tc-HIDA cholescintigram. Serial scintiphotos obtained during the first 60 min demonstrate hepatic uptake and excretion with progressive visualization of the common bile duct (arrow), gallbladder, and small and large intestine. Normal gallbladder contraction is identified at 120 min (30 min after the administration of a fatty meal). Activity is incidentally noted in the bladder at the lower end of the 45 and 60 min scintiphotos, reproduced with permission from Weissmann et al. [7]

New Jersey), BIDA (parabutyl iminodiacetic acid) and DISIDA (di-isopropyl iminodiacetic acid both from New England Nuclear Corp., North Billerica, Massachusetts), are excellent hepatobiliary imaging agents because they are chelates which have successfully combined the ideal physical characteristics of the technetium-99m label with a molecule that is structurally well suited for hepatobiliary uptake and excretion. In particular, of the radiopharmaceuticals currently available, DISIDA appears to be the best “overall agent” [3]. Tc-99m IDA cholescintigraphy is far superior to $^{131}$I-Rose Bengal imaging which is limited by the undesirable physical characteristics of the iodine-131 label, including a physical half-life of 8.1 days and the emission of beta radiation. These factors unnecessarily increase patient exposure, limiting acceptable doses to the microcurie range. In addition, $^{131}$I has multiple gamma photons with a predominant emission of 364 keV which is technically suboptimal for Anger camera imaging. Iodine-123 Rose Bengal has many more favorable characteristics and has shown some promise as an imaging agent [4]. However, its use has been limited to institutions having proximity to cyclotron facilities.

The physical half-life of 6 h, pure gamma emission, and photon energy peak of 140 keV make $^{99m}$Tc ideal for hot laboratory preparation, patient administration, and Anger camera imaging. $^{99m}$Tc-IDA, with its relatively low radiation dose, can be administered in millicurie amounts with a significant improvement in the counting statics and image quality. The dimethyl-acetanilide chain attached to iminodiacetic acid (HIDA) is one of the agents which is most readily available at this time. It meets the structural criteria for hepatobiliary excretion, including a molecular weight of 387, an organic anion, two ring systems in different planes, and firm binding to albumin (Fig. 1). [5]. In the normal individual, approximately 85% of $^{99m}$Tc-HIDA is excreted by the hepatobiliary system in its original molecular form and the remaining 15% is excreted by the kidneys [2, 6]. Clinically, the result is the development of an agent which is a more sensitive indicator of cystic duct patency than the intravenous cholangiogram [7, 8].

Normal Cholescintigram

After 5-10 mCi of $^{99m}$Tc-IDA is injected intravenously, a “blood pool” image is obtained at 1 min, followed by scintiphotos every 5 min for the first half-hour. When necessary, additional views are obtained at 45 min and at 1, 1 $1/2$, 2, 4 h. The study is terminated when activity is identified in the common bile duct, gallbladder, and duodenum which normally occurs within 30-60 min. Cholecystokinin or Sincalide* may be administered intravenously and the contractile response of the gallbladder evaluated. If necessary, a fatty meal may be used for this same purpose (Fig. 2).

Acute Cholecystitis

Since acute cholecystitis is generally associated with cystic duct obstruction, the best diagnostic procedure is one that demonstrates cystic duct patency or obstruction rapidly, with a high degree of accuracy and a low morbidity and mortality. Although it is true that numerous modalities are available for the evaluation of the hepatobiliary system, each has specific weaknesses which limit its applicability, particularly in the acute clinical setting.

Oral Cholecystogram

The oral ingestion of iodinated contrast agents, such as iopanoic acid (Telepaque), may be associated with side effects. Nausea, vomiting, and diarrhea are frequently observed. Fortunately, the more serious reac-

* E.R. Squibb Radiopharmaceuticals, New Brunswick, NJ