

CT fluoroscopy: technique and utility in guiding biopsies of transiently enhancing hepatic masses

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Abstract

We evaluated a new percutaneous biopsy technique for rapid needle localization and biopsy of transiently enhancing focal hepatic masses. Three biopsies in three patients were completed on lesions 18–22 mm in diameter by using computed tomographic fluoroscopy during intravenous contrast enhancement of the liver. All three biopsies were diagnostic.

Key words: Abdomen, biopsy—Computed tomography (CT), guidance—Liver, CT—Liver, biopsy—Liver, neoplasm.

The use of multiphase contrast-enhanced helical computed tomography (CT) has increased sensitivity for detecting small hepatic masses that are not visible on noncontrast-enhanced images and only transiently enhance [1–3]. This creates a new dilemma because not all lesions that transiently enhance are malignant. Furthermore, such lesions may not be amenable to percutaneous biopsy because of their small size and transient conspicuity [3]. The purpose of the present study was to evaluate a new biopsy technique in which CT fluoroscopy (CTF) was performed during dynamic contrast enhancement of the liver to assist with rapid percutaneous needle localization and biopsy of transiently enhancing focal hepatic lesions.

Materials and methods

Patients

Percutaneous localization and biopsy was performed in three patients (two men, one woman; age range = 61–72 years, mean age = 67 years)

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with transiently enhancing hepatic lesions detected by hepatic helical CT. One patient had multiple liver lesions without a history of known malignancy or cirrhosis. Two patients had a history of cirrhosis and solitary hepatic masses. Hepatic lesions in two of three patients were visible only on the arterial phase of triphasic hepatic helical CT examinations. A solitary, transiently enhancing lesion in one patient was detected only on an early portal venous-phase study and was not visible on delayed images or noncontrast-enhanced CT. All three patients underwent ultrasound evaluation of the liver after the helical CT, but none of the lesions was visible with ultrasound.

Imaging

Percutaneous biopsies were performed by using CTF guidance available as a hardware/software package on the Toshiba Xpress-SX scanner (Toshiba American Medical Systems, Tustin, CA, USA). A suitable axial plane for biopsy was obtained by performing CTF and moving the patient into or out of the scan plane by means of remote control until hepatic landmarks in the suspected plane of the lesion entered the axial plane of scanning.

Biopsy procedure

In two patients, localization and biopsy of the target hepatic lesion was performed by using the tandem needle technique [4]. In one patient, an

Table 1. Materials used for computed tomographic fluoroscopy-guided biopsies in three patients

Patient	Localizing needle	Biopsy needle/number of passes
1	20-gauge ^a	22-gauge ^a /1 pass 18-gauge ^b /2 passes
2	22-gauge ^a	22-gauge ^a /1 pass 20-gauge ^a /2 passes
3	18-gauge ^b	Same as localizing needle/3 passes

^a Chiba, Cook, Bloomington, IN, USA

^b Automated core biopsy device, Meditech ASAP, Boston Scientific, Watertown, MA, USA

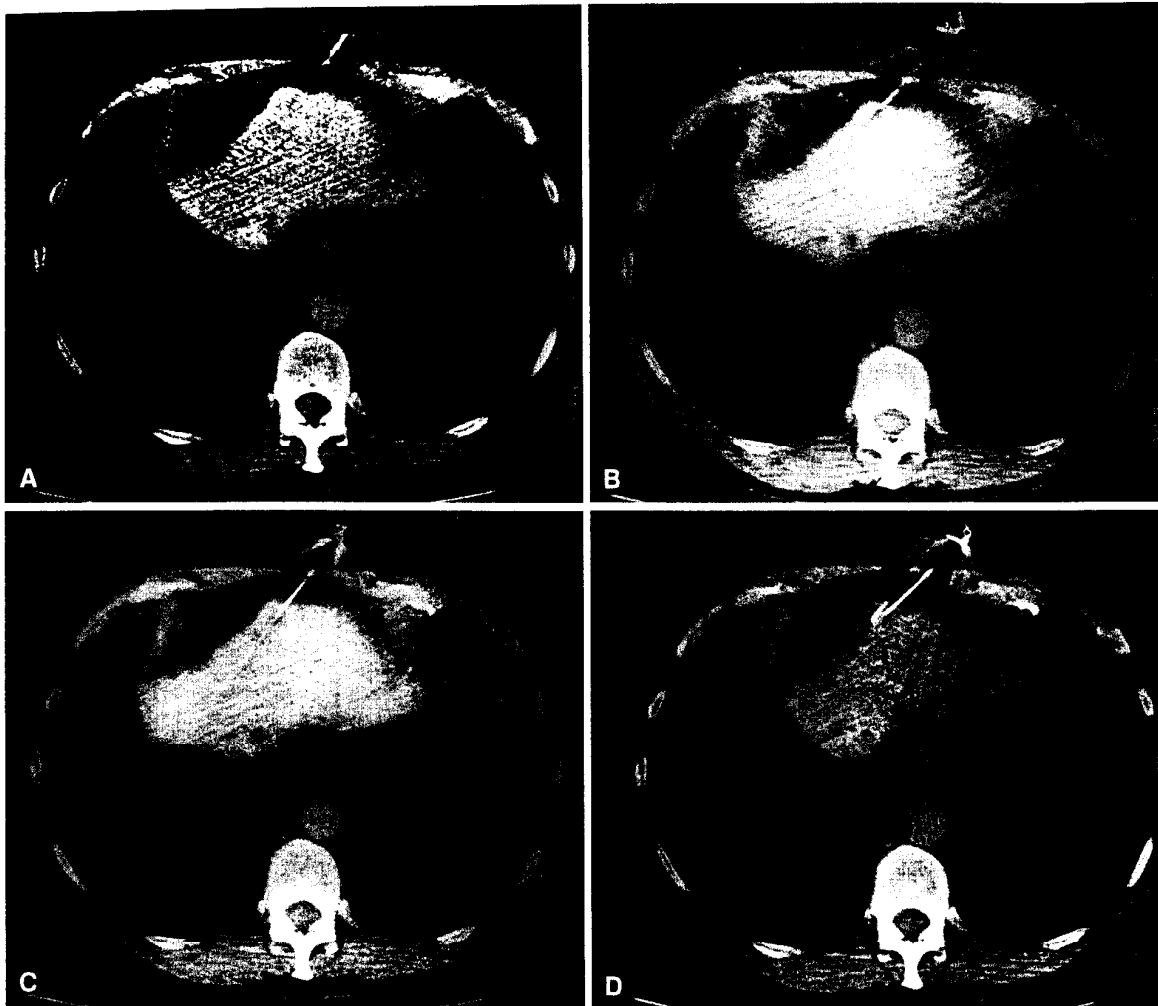


Fig. 1. **A** Reconstructed axial image from CTF biopsy in a 61-year-old man demonstrates a localizing needle in the anterior abdominal wall directed toward a focal hepatic mass, which demonstrates a small amount of contrast enhancement relative to adjacent hepatic parenchyma during the late portal venous phase of contrast enhancement. **B** Reconstructed axial image from CTF demonstrates the localizing needle being advanced through the anterior abdominal wall toward the focal hepatic mass. **C** Reconstructed axial image from CTF demonstrates advancement of the localizing needle into the focal hepatic mass. Once the focal hepatic lesion was visualized and

maintained in the imaging plane, directing and advancing the localizing needle into the lesion took less than 2 s. In real time, this appeared much like a motion picture with images updated every six frames per second. **D** Reconstructed image "frame" from real-time CTF demonstrates final position of a biopsy needle whose tip was placed near the tip of the localizing needle shown in **A**. This aspiration biopsy and two subsequent core biopsies were performed near the tip of the localizing needle. The hepatic mass visible in **A** is isodense with the remainder of the hepatic parenchyma.

18-gauge coaxial core biopsy needle was used as the sole biopsy instrument (Table 1). In each instance, the localizing needle was loaded into a hand-held CTF needle holder (Civco Medical Instruments, Kalona, IA, USA) or was held in place with a hemostat. The tip of each needle was then advanced a short distance into the abdominal wall and angled toward the expected location of the target lesion. With the needle held in a "ready" position, low-osmolar intravenous contrast material (Iohexal, Omnipaque 240, Nycomed, Princeton, NJ, USA) was infused through an antecubital injection site with the same volume (100–150 mL) and rate (2–3 mL/s) as used for the diagnostic CT examination. The time delay between initiating bolus injection of intravenous contrast material and imaging with CTF in each patient was the same as the delay used for the respective diagnostic CT examinations: 20 s in two patients and 40 s in one patient.

Results

Scanning with CTF was initiated 20 s after starting intravenous contrast administration in two patients and 40 s after starting intravenous contrast administration in one patient. These CTF delay times reflected the diagnostic helical CT delay times in which the lesions were visible. In each instance, the target lesion was immediately visible. When the target lesion was positioned in the scan plane without movement, the localizing needle was advanced into it (Figs. 1, 2) or, in the case of the automated

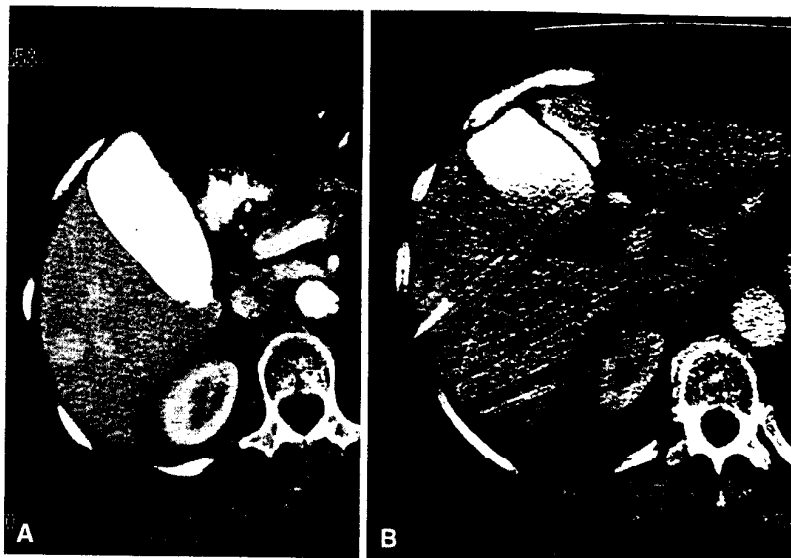


Fig. 2. A Axial CT image from arterial-phase helical CT scan in a 72-year-old woman demonstrates multiple small enhancing lesions within the right lobe of the liver. Lesions were not visible on noncontrast-enhanced or portal venous contrast-enhanced scans. Contrast within the gallbladder is from a recent endoscopic retrograde cholangiopancreatograph. B Reconstructed image "frame" from real-time CTF biopsy during hepatic arterial phase of contrast enhancement demonstrates the tip of the biopsy needle after advancement to the periphery of a transiently enhancing hepatic lesion. The procedure was performed with the patient in the prone position, but the image has been rotated. This lesion was targeted because of its size and location. Note the close proximity of the lung to the biopsy path.

core biopsy device, to the edge of it (Fig. 3). Advancement and precise positioning of the localization needles or core biopsy device took less than 3 s in each case.

Biopsy results are summarized in Table 2. Suitable biopsy material was obtained in all three lesions. None of the patients experienced any complications from the CTF-assisted biopsy procedure. The patient with normal hepatocytes at fine-needle aspiration (FNA) biopsy remains alive and well and has normal liver function tests and stable follow-up CT 1 year postbiopsy. We speculate that these lesions represent a benign process such as multiple foci of focal nodular hyperplasia or hepatic adenomas.

Biopsy time in our first case was approximately 45 min and included time from beginning the contrast injection to removing the last biopsy needle. Biopsy time for the last two cases was approximately 10 min.

Discussion

CTF is a new technique that provides "real-time" CT image guidance to assist in percutaneous intervention [5–8]. CTF allows image acquisition, reconstruction, and display in a stationary position in the z-axis at a rate of six frames per second by performing image acquisition and processing after an initial 360° gantry rotation and repeatedly updating images after each subsequent 60° arc. As is done with standard fluoroscopy, the person performing the procedure can control CTF scanning by means of a foot pedal. A monitor in the room allows the operator to perform precise needle positioning within a lesion and provides immediate feedback for performing compensatory adjustments in needle position due to inaccurate

needle positioning or rebound of subcutaneous tissue [5–8].

Real-time CTF significantly decreases biopsy procedure time by decreasing the number of needle passes and time required for compensatory needle manipulation and documentation of needle positional changes [5–8]. CTF has been used to assist percutaneous biopsy of lesions in the chest, abdomen, and pelvis. As yet, there has been no report of a percutaneous procedure using real-time CTF during dynamic contrast enhancement.

None of these lesions were visible on noncontrast-enhanced CT. Shortly after contrast administration, each lesion became isodense with adjacent hepatic parenchyma. Therefore, by using contrast-enhanced CTF assistance, we performed rapid localization of transiently enhancing hepatic masses in three patients.

All lesions were visible as soon as contrast-enhanced CTF was initiated: 20 s in two patients and 40 s in one patient. Based on temporal measurements of delay times for the diagnostic CT examinations and the visibility of the lesions at CTF, we estimate that hepatic lesions in two patients (patients 2 and 3) became isodense with adjacent liver parenchyma 50–60 s after starting the bolus injection of intravenous contrast material. We estimate that the solitary hepatic lesion in another patient (patient 1) became isodense with adjacent liver parenchyma approximately 80 s after starting the bolus injection of intravenous contrast material. These brief periods of lesion conspicuity require localizing a suitable plane where the target lesion is suspected prior to administering contrast because small changes in the degree of breath-hold may result in the lesion becoming displaced from the scan plane, subsequently delaying localization.

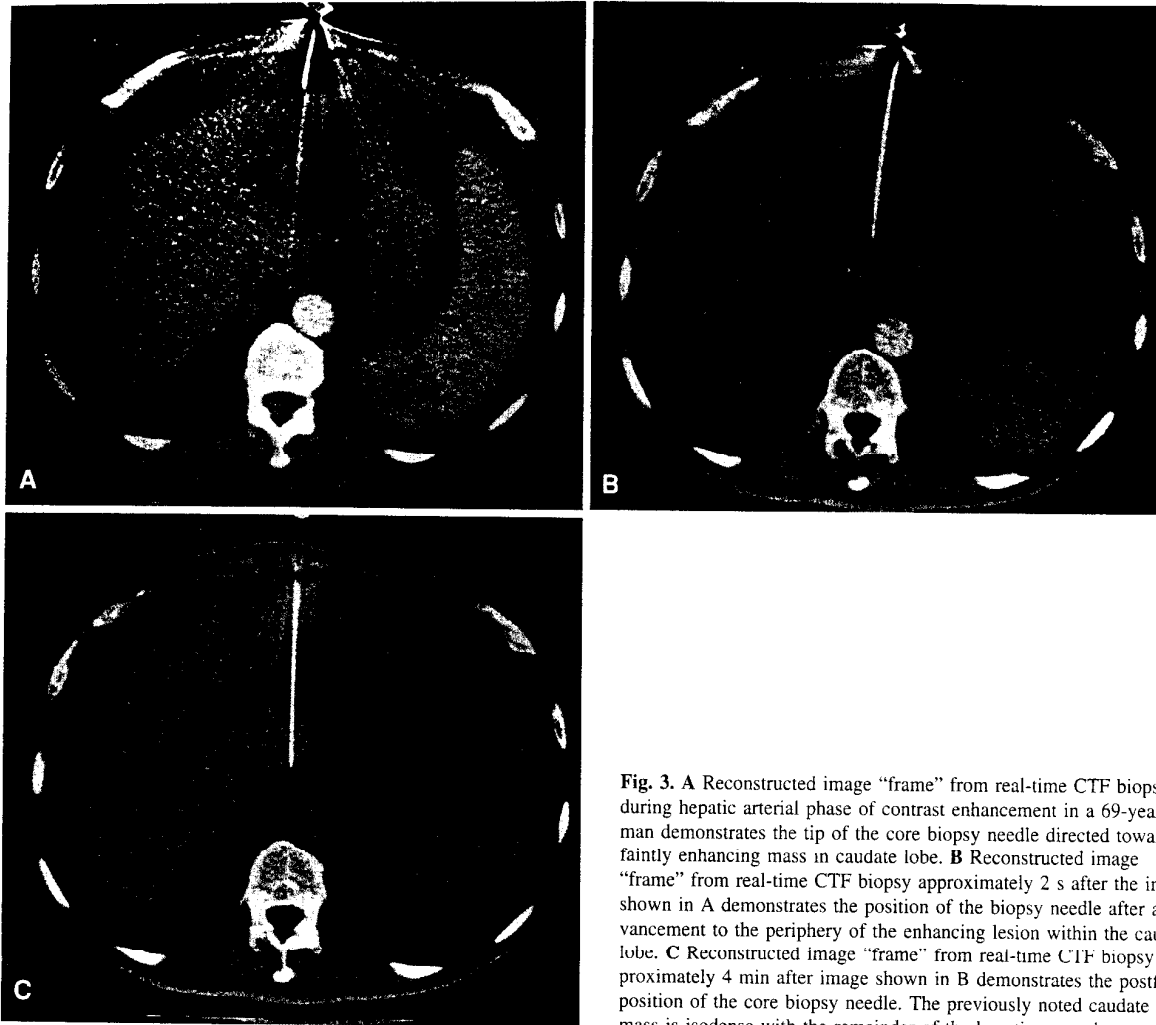


Fig. 3. **A** Reconstructed image "frame" from real-time CTF biopsy during hepatic arterial phase of contrast enhancement in a 69-year-old man demonstrates the tip of the core biopsy needle directed toward a faintly enhancing mass in caudate lobe. **B** Reconstructed image "frame" from real-time CTF biopsy approximately 2 s after the image shown in **A** demonstrates the position of the biopsy needle after advancement to the periphery of the enhancing lesion within the caudate lobe. **C** Reconstructed image "frame" from real-time CTF biopsy approximately 4 min after image shown in **B** demonstrates the postfire position of the core biopsy needle. The previously noted caudate lobe mass is isodense with the remainder of the hepatic parenchyma.

Table 2. Histologic diagnosis of three dynamic contrast-enhanced computed tomographic fluoroscopic liver biopsies in three patients

Patient	History	Target lesion size	Biopsy device	CT biopsy diagnosis
1	Cirrhosis	22 mm	FNA + Core	Hepatocellular carcinoma
2	Multiple liver masses/Unknown primary	18 mm	FNA	Benign hepatocytes
3	Cirrhosis	20 mm	Core	Hepatocellular carcinoma

FNA, fine-needle aspiration

In each instance, needle position could have been verified by performing contrast-enhanced CT scanning after the localizing needle had been advanced into the expected location of the target lesion. However, this would have prolonged procedure time. Furthermore, additional scans after supplementary needle manipulations may have been limited by requirements for additional intravenous contrast. With our real-time technique, satisfactory needle localization was achieved in seconds with a single dose of intravenous contrast.

Total biopsy time in our first patient was relatively long (45 min). This length of time reflected our inexperience using CTF and the presence of a cytopathologist who reviewed each FNA specimen after removal. Biopsy time in our other two cases was significantly reduced (<10 min).

Focal hepatic lesions that are visible on noncontrast-enhanced CT scans may be less conspicuous during noncontrast-enhanced CTF due to the lower photon current (50 mA) and smaller reconstruction matrix (256 × 256)

used for CTF. Therefore, in addition to using intravenous contrast-enhanced CTF to visualize focal hepatic lesions that are only transiently visible on contrast-enhanced helical CT, as in the three patients described in the present study, we have used intravenous contrast-enhanced CTF to increase conspicuity of small hepatic lesions that were visible on noncontrast-enhanced CT scans but rendered less conspicuous on noncontrast-enhanced CTF.

Using intravenous contrast-enhanced CTF to provide assistance for biopsy of transiently enhancing hepatic lesions may gain additional importance in the future. Helical CT of the liver is routine at many institutions and has resulted in increased sensitivity for detecting transiently enhancing hepatic masses [1-3]. Unfortunately, not all of these lesions are amenable to biopsy because of their transient conspicuity [3].

In summary, we have described a new technique using CTF during dynamic contrast enhancement of the liver. This technique allowed for rapid localization and biopsy of hepatic masses in three patients. These lesions were isodense with adjacent hepatic parenchyma on noncontrast-enhanced CT and only transiently visible on contrast-enhanced CT.

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