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# Staging of Hepatocellular Carcinoma by Ultrasonography, Computed Tomography, and Angiography: The Role of CT Combined with Arterial Portography

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**Abstract.** A series of 60 patients with hepatocellular carcinoma (HCC) were evaluated over a 2-year period of ultrasonography (US), computed tomography (CT), and angiography. The angiographic studies carried out with intraarterial digital technology were compared to both US and CT of the liver. In 16 of 60 patients, we observed discordance of the findings obtained with angiography, CT, and US. We therefore compared these three methodologies in those cases where diagnostic discordance was noted. In our experience, US had a sensitivity of 73.4%, 76.7% for CT, and 95% for angiography. In 13 of 60 patients, we performed CT with arterial portography (CTAP) which demonstrated a better resolution than conventional CT. In view of the sensitivity of US – comparable to that of CT – and for the even greater sensitivity of intraarterial digital angiography, we performed an US study of patients at risk of HCC. CT was found to play a diagnostic/staging role after angiographic study has been performed, especially when enhanced by arterial portography.

**Key words:** Hepatocellular carcinoma, US, CT, and angiography.

Hepatocellular carcinoma (HCC) is the most common primary tumor of the liver, and its correct management greatly depends on a precise clinical and radiological assessment. The frequent concomitance of liver cirrhosis and the possible coexistence of intrahepatic metastatic nodules are critical conditions for proper therapeutic planning.

We therefore consider it necessary to establish a methodological approach to the diagnosis and staging of HCC, and to devise the most sensitive x-ray studies.

The wide use of ultrasonography (US), as a control method in patients at risk of HCC, contributed to extend the use of this procedure to the diagnosis of intrahepatic nodular lesions. Furthermore, US represents a valuable screening method, as it is noninvasive, of low cost, easily reproductible, and provides an easy approach to needle biopsy [1, 2]. Computerized axial tomography (CT), beyond providing a precise biopsy approach to nodules that cannot be easily viewed by US, also allows a better definition of liver anatomy, especially in postsurgical cases [1–4].

Magnetic resonance imaging is a very sensitive method, especially in the demonstration of hepatic hemangiomas. In the detection of hepatic primary tumors it has the same value as CT, but interventional procedures cannot be performed [6–8].

Intraarterial digital angiography offers the possibility of assessing the liver vascular pattern for therapeutic purposes and is also characterized by a greater diagnostic sensitivity. The literature on the diagnostic sensitivity of US, CT, and angiography in HCC provides discordant data, with a sensitivity for US ranging between 54 and 73%, between 58 and 77% for CT, and between 75 and 93% for angiography [9–11].

On the basis of our experience, we compared the sensitivity of these three methods in the diagnosis of HCC.

## Materials and Methods

Over a 2-year period, we studied 60 patients with HCC. Forty-two men and 18 women, with an age range between 42 and 78 years, were assessed by US, CT, and angiography. US and CT were always carried out before angiography, which was performed for the purpose of obtaining presurgical assessment in operable patients or to implement chemoembolization therapy in nonoperable cases.

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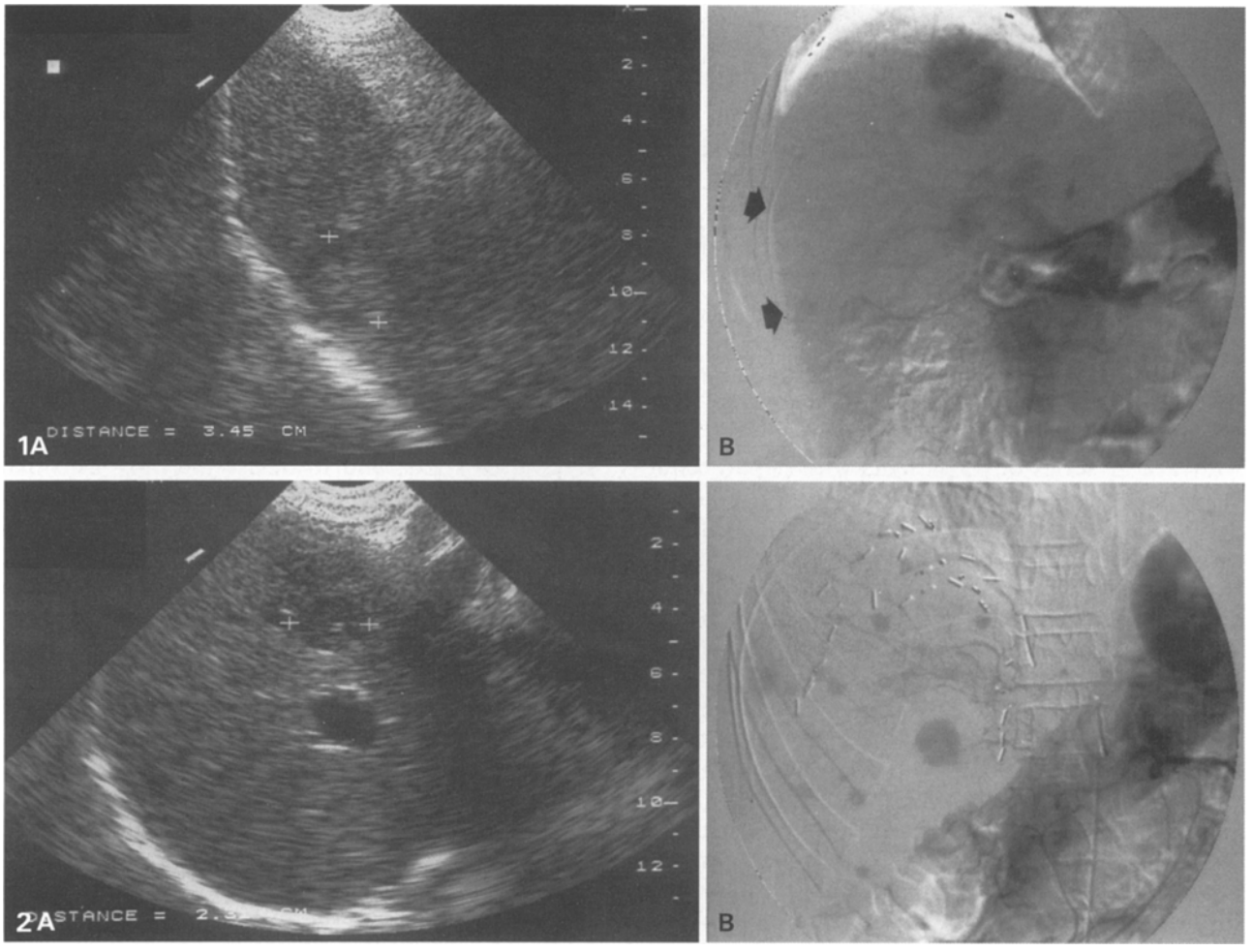


**Fig. 1.** Hepatocellular carcinoma. **A** A solitary neoplastic lesion, 3.5 cm in diameter, is demonstrated by US. **B** The parenchymal phase of angiography demonstrates other small neoplastic nodules of a few millimeters in diameter (*arrows*), later confirmed at surgery.

**Fig. 2.** Hepatic tumor relapse in a previously operated patient. **A** The largest lesion demonstrated by US is 2.3 cm in diameter. The presence of surgical metal clips makes US study difficult. **B** A number of micronodular neoplastic lesions of less than 1 cm are demonstrated by angiography.

In those cases showing discordance among the different diagnostic procedures, the US study was repeated by two different radiologists, whereas CT was reviewed later on in the light of any possible new findings. We observed discordance of the results obtained with the three methods in 16 patients, who all showed pathological levels of alpha-feto-protein, which ranged between 90 and 730. Angiography, CT, and US were always performed within the same department. In all cases the diagnosis of neoplasm was performed by needle biopsy or by alpha-feto-protein assay, whenever the level was greater than 400 U.

Intraarterial digital angiographic studies were performed with a Siemens Digitron by selective catheterization of the hepatic artery and digital technology for the angiographic sequence. CT studies were carried out with a Siemens DRH with scans taken before and after intravenous injection of contrast agent. US studies were performed with an ATL Ultramark 8 with a 3.5-MHz sector transducer.

CT with arterial portography (CTAP) was performed after angiographic study exploiting the intraarterial catheter and therefore performing a selective injection into the splenic or upper mesenteric artery during CT examination.

## Results

The results are shown in Table 1. In 44 of 60 patients studied during the 2-year period, we obtained homogeneous results in all three diagnostic

**Table 1.** Diagnostic discordance: US, CT, and angiography in 16 of 60 cases of HCC (26%)

| | False-negative cases | Under-estimated cases | Sensitivity |
|---|---|---|---|
| US | 4 | 12 | 44/60 (73.4%) |
| CT | 1 | 13 | 46/60 (76.7%) |
| Angiography | 2 | 1 | 57/60 (95%) |

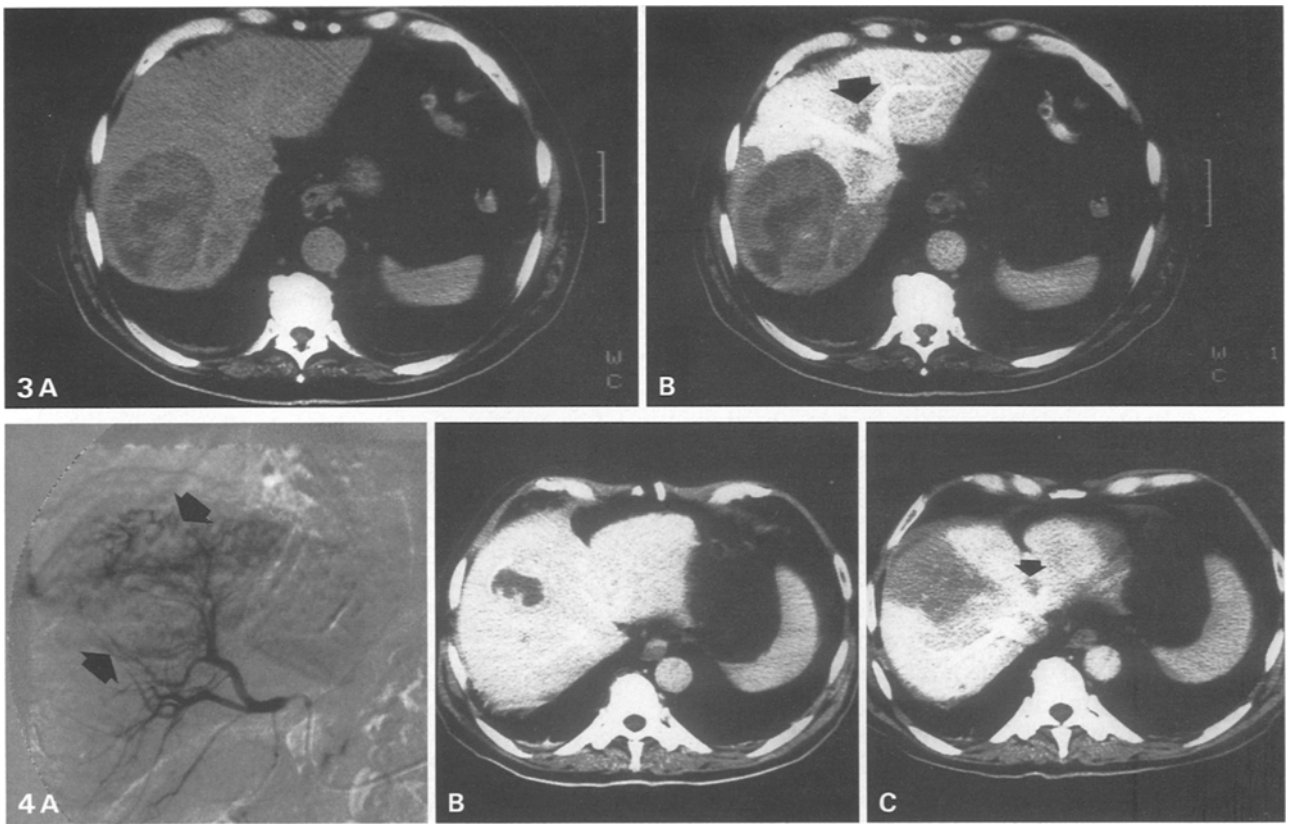


**Fig. 3.** Hepatocellular carcinoma. **A** Enhanced CT demonstrates one lesion in the hepatic VII segment. **B** CTAP demonstrates another smaller lesion in the IV segment, later confirmed at surgery (*arrow*).

**Fig. 4.** Hepatocellular carcinoma in a cirrhotic patient. **A** Neoplastic vascularization in the subdiaphragmatic region (*arrows*) is seen after angiographic study. **B** Enhanced CT shows a solitary lesion. **C** CTAP demonstrates a wider neoplastic involvement and another satellite neoplastic lesion in the left lobe (*arrow*), later confirmed by percutaneous biopsy.

procedures. Diagnostic discordance occurred in 16 subjects (26% of our patient population).

US underestimated the number of nodules in 12 patients and CT in 13 cases, compared with intraarterial digital angiography, which only underestimated 1 case.

Most of the nodules that could not be demonstrated by US were smaller than 1 cm (Figs. 1 and 2). We obtained false-negative US findings in four cases, false-negative CT findings in one case, and false-negative angiography findings in two cases. The cases which proved negative at angiography were also characterized by alpha-feto-protein levels above 500 U, and correct diagnoses were established by CTAP, which demonstrated a nodule of 1 cm and another of 1.5 cm in diameter, which could not be otherwise demonstrated by angiography or US. The lesion that had not been observed at CT was clearly described by intraarterial digital angiography. All four false-negative cases after US study were shown by intraarterial digital angiography and CTAP. CTAP scans taken during splenoportography demonstrated hepatic nodules which were not visible with the traditional tomographic procedure [11–14]. This approach therefore provides more precise staging opportunities, based on the number and anatomy of the lesions (Fig. 3). Of 60 patients with liver cancer who underwent angiography, US and standard CT, we performed CTAP in 13 patients: in three cases we obtained a better diagnostic definition through CTAP, which demonstrated intrahepatic nodules that had not been demonstrated by other diagnostic procedures. Both needle biopsy combined with CTAP and surgery provided confirmation of cancer diagnosis (Fig. 4).

## Discussion

The high incidence of cirrhosis degenerating into HCC determined the need to carry out repetitive US controls in patients at risk. The advances and the widespread use of US make this procedure par-

ticularly indicated in the diagnosis of intrahepatic nodules, which is proposed as a noninvasive and low-cost screening method which can be easily repeated [1, 15, 16]. The need to properly stage this disease in the case of intrahepatic metastases coexisting with the primary hepatocellular tumor is of critical importance. It is therefore extremely useful to compare the results obtained with the three most widely used diagnostic procedures – US, CT, and intraarterial digital angiography – in order to properly define the level of sensitivity for each diagnostic approach.

US is the procedure of choice in the study of the liver, being easily accessible, free of any possible risk, and repeatable. CT provides images which are easy to analyze and compare, and also allows dynamic study through intravenous contrast and two-dimensional evaluation, and compared to angiography also provides the possibility of demonstrating superimposed nodular lesions.

Our experience in 60 cases indicated a diagnostic discordance in the demonstration of intrahepatic focal lesions in 16 patients: US underestimated the number of nodular lesions in 12 patients, CT in 13 patients, and angiography in one patient. False-negative results were obtained with US in four cases, and CT in one case, because the neoplastic lesions had the same echostructural and tomodensitometric characteristics as the hepatic parenchyma. In two cases, angiography did not allow imaging of a neoplastic nodule which was instead visible with CTAP. In our experience, US had a sensitivity of 73.4%, and 76.7% for CT. Intraarterial digital angiography is the most sensitive method in the diagnosis of HCC, with a sensitivity of 95%. If angiographic study gives a negative result in a patient with clinically suspected tumor, we recommend performing CTAP immediately after the angiographic session. CTAP proved to have a greater diagnostic value than US, standard CT, or angiography; thus, this procedure should always be proposed in the study of both primary and secondary hepatic cancer in those cases requiring maximum diagnostic resolution and staging parameters.

US still remains the procedure of choice for screening purposes and for the preliminary study of patients at risk. Whenever unclear intrahepatic lesions are demonstrated or the presence of altered alpha-feto-protein levels are found with negative US, we suggest that angiographic study be performed.

In order to obtain maximum sensitivity, CT can be performed immediately after angiographic study and combined with arterial portography, exploiting the presence of the catheter into the splenic or superior mesenteric artery.

CTAP can also provide an opportunity to perform needle aspirates of nodules that were not demonstrated by other diagnostic procedures.

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