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Adding Liver Window Setting to the Standard Abdominal CT Scan Protocol: Is It Useful?

Background/Objective: Hepatic lesions may be missed in the routine abdominal computed tomography (CT) scan protocol using soft tissue window setting. The ability to find these lesions is very important in the assessment of metastasis and follow-up of patients.

Patients and Methods: In this study, 411 patients who underwent abdominal CT for various causes were evaluated separately by two radiologists blindly. All liver images were viewed in two different window settings, soft tissue window setting: window width (WW) of 350-400 Hounsfield unit (HU), window level (WL) of 35-50 HU, and liver window setting: WW of 150 HU, WL of 50-100 HU, at the workstation.

Results: Out of 411 patients, 181 (44%) were referred for cancer follow-up and 230 (56%) for evaluation of abdominal discomfort. Soft tissue window setting revealed no lesion in 334 (81.26%) patients, single lesion in 30 (7.31%), and multiple lesions in 47 (11.43%) patients. Liver window setting revealed no lesion in 313 (76.2%) patients, single lesion in 35 (8.5%), and multiple liver lesions in 63 (15.3%) patients. Compared to liver window, soft tissue window setting revealed 77.77% of all detectable liver lesions. Liver window showed new lesions in 22 (6.6%) of patients in whom no lesion had been found in soft tissue window setting. Therefore, liver window setting brought 5.3% increase in the diagnostic yield of CT in our series, and changed the decision for treatment in 2.4% of patients studied.

Conclusion: Liver window setting added to the standard soft tissue setting protocol of abdominal CT at the workstation can improve the diagnosis and follow-up of patients, especially for those who have known cancer. Image review with this new setting takes a few minutes and the cost is also low; there is no added radiation exposure to patients.

Keywords: Computed Tomography, Abdomen, Liver Window Settings

Introduction

There is a great range of benign and malignant disease processes affecting the liver. In several studies, liver lesions were found in 12.7%–29.4% of patients with known cancer and other suspected abdominal symptoms.¹⁻³ Therefore, the liver should be routinely investigated in many patients, particularly in those who have malignant diseases.

Many imaging modalities including ultrasound, computed tomography (CT), positron emission tomography (PET) and magnetic resonance imaging (MRI) as well as radiologic interventional procedures have been developed for assessment of the liver. CT has always played a major role in liver imaging. Moreover, recent development in multidetector-row CT technology has further improved the significant role of CT.⁴ Optimizing CT evaluation of hepatic lesions using dedicated hepatic window settings may be effective in maintaining its already established role and somewhat enhances its task. The liver is usually evaluated in abdominal CT scans using a preset soft tissue window setting including a window width (WW) of 350–400 Hounsfield units (HU) and a window level (WL) of 35–50 HU in different CT scanners. This window setting is optimal for the general review of the abdomen. However, this setting could easily miss some hepatic

Table 1. Frequency of Lesions Detected Using Two Window Settings

Nature of the lesions	Frequency	Percent
Metastasis	64	15.57
Hemangioma	14	3.40
Cyst	11	2.67
Abscess	3	0.73
Granuloma	2	0.49
FNH	1	0.24
Fatty liver	1	0.24
Hydatid cyst	1	0.24
Adenoma	1	0.24
No lesion	313	76.16
Total	411	100

lesions which have similar densities to the normal liver parenchyma, and would not be displayed otherwise.⁵ This may change the diagnosis, the management plan and follow-up of the patients.⁶⁻¹⁰ In this study, we compared the diagnostic yields of abdominal CT in detecting liver pathologies in a series of patients, using two window settings.

Patients and Methods

We evaluated 411 patients who were referred to our center for abdominal CT scan. Based on the presenting symptoms and history, they were categorized into two groups:

- 1- Follow-up of a known malignancy
- 2- Patients with any abdominal symptoms of an unknown etiology and indications for abdominal CT scan

All scans were obtained by a 4-detector-row CT scanner (Light Speed QX/I; GE Medical Systems, Milwaukee, WI). Helical examinations were done by injecting 60–100 mL of contrast medium (Iopromide [Ultravist] 300 mg I/mL; Schering; Berlin; Germany) depending on the body weight. Image acquisition was performed in portal venous phase, *i.e.*, 50–60 sec post-injection. The collimation was five mm and the pitch was 1.5.

According to the normally known contrast-enhanced hepatic parenchymal density, including a narrower WW (150 HU) and a higher WL (50–100 HU), we used another specific hepatic window setting to visualize liver lesions at the workstation. This window setting was applied to all cases at the

workstation following the standard soft tissue window setting. All images were interpreted separately by two radiologists who had 13 and six years of experience in body CT scan. At first, images were viewed with standard soft tissue window setting and thereafter, they were evaluated with specific hepatic window setting. The number of lesions found in these two window settings which were seen using a NEC MultiSync LCD1880SX 18.1" LCD Flat-panel Monitor (1280×1024 SXGA resolution, 60–75 Hz, 350:1 contrast ratio). The data were recorded for each patient, separately.

Results

Four-hundred and eleven patients were evaluated. One-hundred and ninety-nine (48.4%) patients were male and 212 (51.6%) were female. The patients' age ranged from seven to 81 years. Of 411 patients, 181 (44%) were examined for the follow-up of a known cancer and 230 (56%) were evaluated for abdominal symptoms (*e.g.*, abdominal pain, fullness, tenderness, change in bowel habits, nausea and vomiting) with an unknown etiology. Using the standard window setting, we found 334 (81.26%) patients with no lesion, 30 (7.3%) with a single lesion, and 47 (11.43%) with multiple lesions. Liver window setting revealed 313 (76.2%) patients with no lesion, 35 (8.5%) with a single and 63 (15.3%) with multiple hepatic lesions. Of those patients who had liver lesions, 64 (65%) had liver metastases (Table 1).

Agreement among radiologists was evaluated by the Bland-Altman method. Disagreement between the two radiologists on the number of liver lesions detected by the standard window setting and the liver window setting was in six (1.46%) and 16 (3.89%) of 411 patients, respectively (Fig. 1). Therefore, the data was analyzed based on the mean number of lesions detected by the two radiologists. Liver window setting showed lesions in 22 (6.6%) more patients who had no lesion according to the standard window setting.

Thus, compared to the liver window setting, standard window setting could detect only 77.8% of all the detectable liver lesions. Of these 22 new cases, 11 had benign liver lesions (hemangioma in three, cyst in five, liver granuloma in one, adenoma in one, and

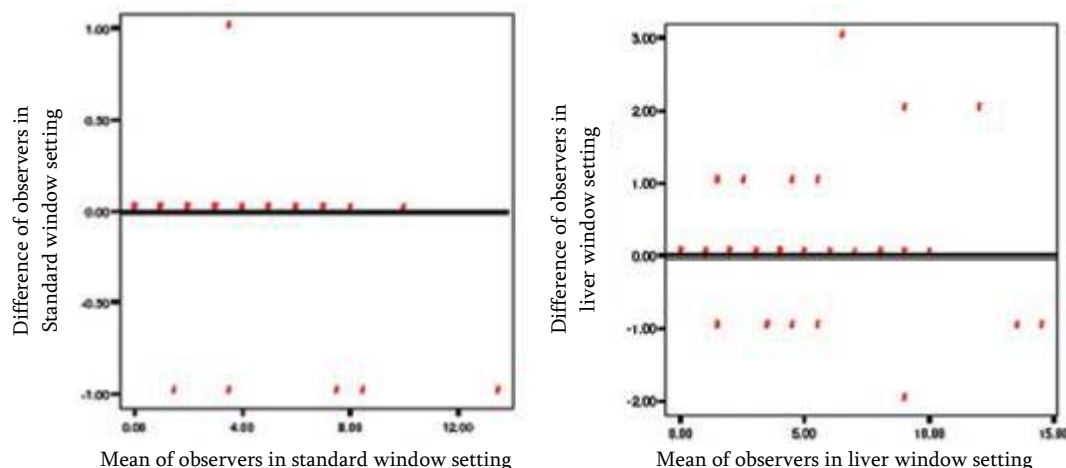


Fig 1. Bland-Altman chart for assessing the level of agreement between the two radiologists.

FNH in another patient). The remaining 11 patients of this group had liver metastases from the gastrointestinal, genitourinary or breast cancers (Table 2 and Figs. 2 and 3). In this group, there were no additional findings of malignancy such as ascites, other organ involvement or lymphadenopathy. Therefore, liver window setting brought 5.3% increase in the diagnostic yield of CT in our series, and changed the decision for treatment in 2.4% of the patients studied. The analysis of the difference between the standard window setting and liver window setting regarding the lesion detection rate was done applying χ^2 test. The result showed that the observed difference was highly significant ($p < 0.0001$). The diameter of the smallest lesion detected by liver window setting was six mm, and its density was almost 20 HU lower than that of the normal liver parenchyma in the portal venous phase. In all hypodense lesions, liver window setting showed a sharper definition compared to that displayed by the standard window setting (Figs. 4 and 5).

Discussion

In the study of Schwartz et al.¹ on 2978 patients, 12.7% of the liver lesions were found in cancer patients. Jones et al.² found lesions in 17% of 1454 pa-

tients who were evaluated for known cancer or other suspected symptoms. Moreover, in the study of Khalil et al.³ on women with breast cancer, up to 29.4% of the patients had liver metastasis. However, in our study 64 (15.6%) out of 411 patients had liver metastases.

This study showed that liver window setting brought 5.3% (95% CI: 3.4%–8.0%) increase in the diagnostic yield of CT compared to the standard soft tissue setting in different liver diseases. Applying liver setting, we could find additional metastasis among 10 out of 64 cancer patients, resulting in detection of 15.6% more cases among this group. Using this window setting, we could find a new lesion in a patient with abdominal discomfort which came out to be liver granuloma. This study resulted in change in the diagnosis, follow-up and the treatment plan in 2.7% (95% CI: 1.3%–4.7%) of the patients.

All the mentioned figures we reported were higher than those reported by Mayo-Smith et al.⁶—3.1% new lesions, 1.7% change in diagnosis and 0.87% change in treatment and follow-up.

Furthermore, our figures were lower than those of Pomerantz, et al,¹¹ study that reached 18% change on the final diagnosis. The latter comparison implies that adding this setting at the workstations has more benefits, especially in patients with known cancers

Table 2. Frequency of Patients Who Had Lesions Found Using the Liver Window Setting Not Discovered by the Standard Window Setting

Patient group \ Type of lesion	metastasis	hemangioma	cyst	granuloma	adenoma	FNH	Total
Follow-up for a known cancer	10	3	1	0	0	0	14
Abdominal discomfort	1	0	4	1	1	1	8
Total	11	3	5	1	1	1	22



Fig 2. A 55-year-old man with colon cancer.
A. There was no detectable lesion in the standard window setting.
B. After using the liver window setting the metastatic lesion was detected.

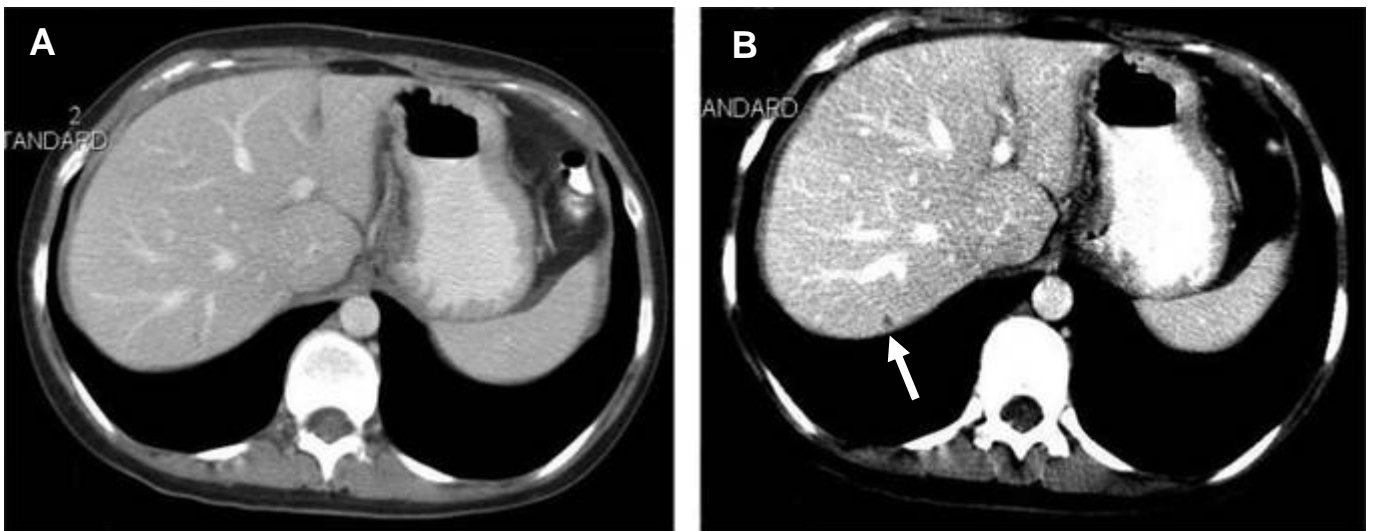


Fig 3. A 49-year-old woman with cystic tumor of the ovary.
A. There was no detectable lesion in the standard window setting.
B. There was a hypodense peripheral lesion in the liver window setting.

without other findings of metastasis like other organ involvement, lymphadenopathies or ascites.

Review of the images through this added setting at the workstation only takes a few minutes and does not require any particular expertise of technologists. Moreover, since images are reviewed as a soft copy, there is no need for additional hard copy printing, hence, no need for additional cost that would restrict the factors in the use of this setting in abdominal CT scan protocol by Mayo-Smith⁶ and Pattan.⁹ The most likely causes of the difference observed between this study and the previous studies were employing thin

high-resolution slices acquired by a multidetector CT scanner and also using viewers instead of the hard copy. Another difference would be due to the population under study which included both patients with general symptoms and those with known cancers. In our study, the mean time to review liver images by this new setting was three minutes.

The increase in the capability in detection of new lesions in patients with cancer leads to change in the diagnosis, follow-up and treatment plan and thus we recommend using liver window setting, especially in this group of patients. Using this window setting in

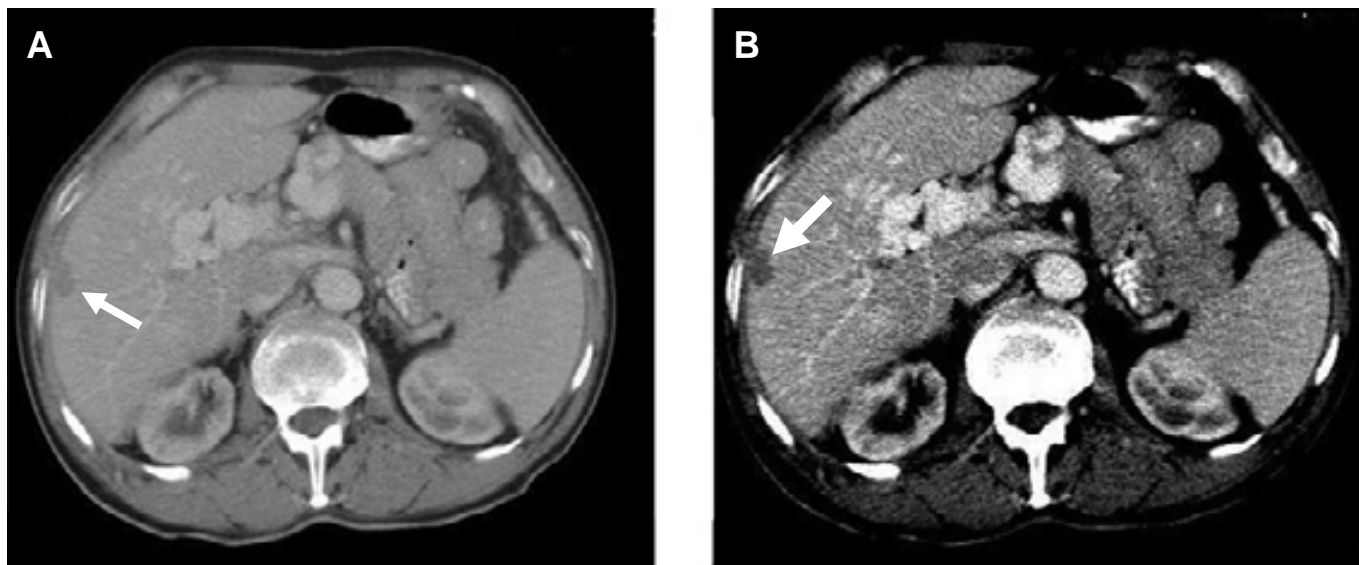


Fig 4. A 41-year-old man with metastatic renal carcinoma.
A. A lesion was seen in the standard window setting.
B. Note the sharply demarcated lesion in the liver window setting.

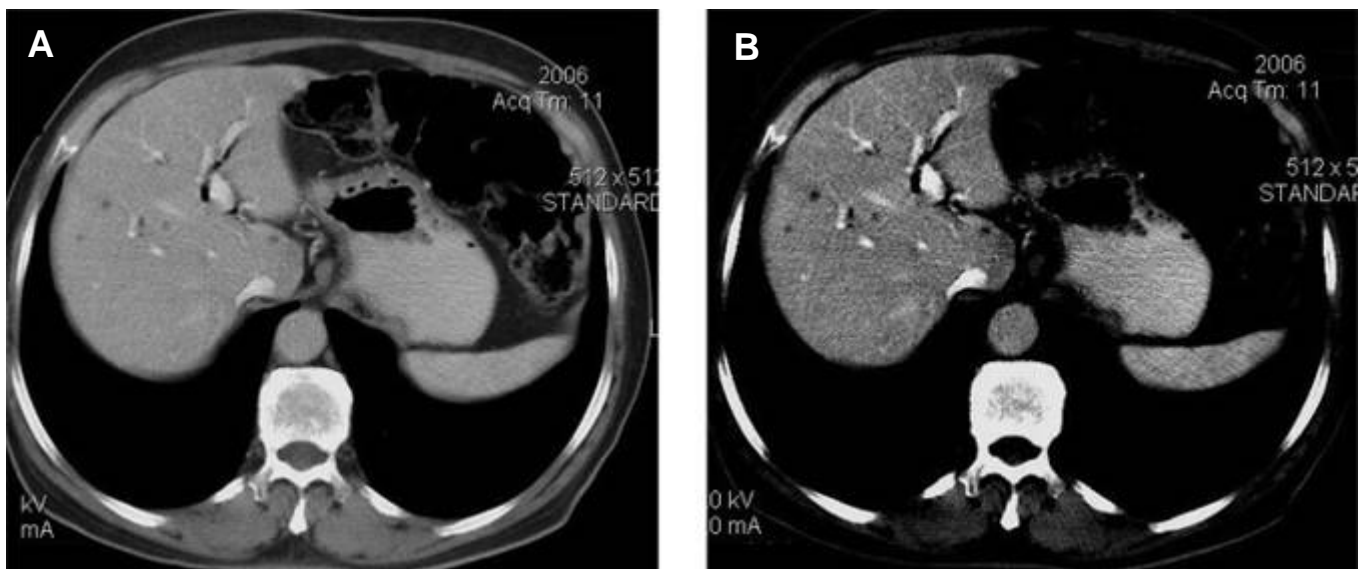


Fig 5. A 35-year-old woman with breast carcinoma and liver metastases.
A. Multiple metastases are detected in the standard window setting.
B. They are better demarcated in the liver window setting.

all patients who have abdominal symptoms and need to undergo abdominal CT would be beneficial.

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