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## Solitary necrotic nodule of the liver: imaging and correlation with pathologic features

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### Abstract

We describe two cases of solitary necrotic nodule of the liver, an uncommon nonmalignant lesion that can mimic a metastasis. The nodule appeared hypoechoic, or target-like, on sonography, hypodense without contrast enhancement on computed tomography, and hypointense on magnetic resonance imaging, including diffusion-weighted images. These features, peculiar when considered together, are explained by the coagulative type of necrosis.

**Key words:** Solitary necrotic nodule—Liver, focal lesions—Ultrasound—Computed tomography—Magnetic resonance imaging—Diffusion weighted imaging—Coagulative necrosis.

Solitary necrotic nodule (SNN) of the liver was originally described by Shepherd and Lee in 1983 as an uncommon nonmalignant lesion of uncertain etiology, usually localized in the subcapsular region of the liver, that often can be misinterpreted as a single metastasis [1]. We report the radiologic features in two cases of SNN and their correlation with the pathologic findings.

### Case reports

#### Case 1

A 52-year-old man underwent abdominal ultrasound (US) for staging of gastric cancer. US showed a diffusely bright, fatty liver with a hypoechoic nodular lesion 8 mm in diameter localized in segment VII (Fig. 1A).

Dynamic triple-phase computed tomography (CT) of the liver was performed on a Somatom Plus-4 scanner (Siemens, Erlangen, Germany). In the basal acquisition, the lesion in segment VII appeared slightly hypodense compared with the normal liver parenchyma. In the arterial, portal, and delayed phases, the lesion showed no contrast enhancement and became more conspicuous after enhancement of the normal surrounding parenchyma (Fig. 1B).

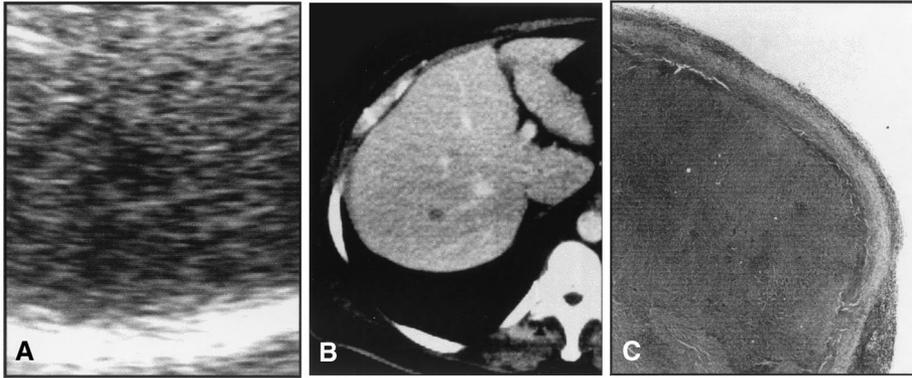
The patient also underwent magnetic resonance imaging (MRI) on a 1.5-T Gyroscan ACS NT (Philips, Eindhoven, The Netherlands). Axial images 5–8 mm thick were obtained with breath-hold fast field echo (FFE) T1-weighted (T1W; repetition time [TR] = 110 ms, echo time [TE] = 1.8 ms, flip angle [FA] = 80°), respiratory gated turbo spin echo (TSE) T2W (TR = 4000 ms, TE = 180 ms, turbo factor [TF] = 22), and breath-hold gradient-spin echo (GRASE) spectral saturation inversion recovery (SPIR) T2W (TR = 1387 ms, TE = 105 ms, TF = 12, echo planar imaging [EPI] factor = 3) sequences. MRI confirmed the presence of a solitary lesion that exhibited marked hypointensity in all sequences.

Because the nodule was misinterpreted as a metastasis, during gastrectomy, the patient also underwent wide excision surgery of the nodular lesion of segment VII.

The lesion histologically was composed of a central, completely necrotic, acellular, eosinophilic core without detectable vessels, surrounded by a thin fibrotic capsule of collagen and elastic fibers with scanty mononuclear inflammatory cells (Fig. 1C). The hepatic tissue surrounding the lesion was normal. The final diagnosis was SNN of the liver.

#### Case 2

A 30-year-old woman underwent abdominal US for dyspeptic symptoms. Routine blood and urine analyses were



**Fig. 1.** Case 1. **A** US shows a bright, fatty liver with a hypoechoic nodular lesion, 8 mm in diameter, localized in segment VII. **B** Helical CT in the portal phase after intravenous administration of iodinated contrast material shows a nonenhancing hypodense nodular lesion in segment VII. **C** Surgical specimen of the solitary necrotic nodule of the liver. Hematoxylin and eosin; original magnification, 40 $\times$ . The lesion is composed of a central, completely necrotic, acellular, eosinophilic core without detectable vessels and surrounded by a thin fibrotic capsule of collagen and elastic fibers with scanty mononuclear inflammatory cells.

normal. She had no history of trauma, neoplasm, tuberculosis, syphilis, or parasitic infestations.

US showed a 15-mm hypoechoic nodular lesion resembling a secondary solitary mass in the subcapsular portion of segment VI (Fig. 2A). Doppler US showed no flow within or surrounding the lesion.

Dynamic triple-phase CT of the liver was performed on a Somatom Plus-4 scanner (Siemens). The lesion appeared slightly hypodense compared with the normal liver parenchyma, without detectable enhancement on all contrastographic phases (Fig. 2C).

The patient also underwent MRI on a 1.5-T Gyroscan ACS NT (Philips). Axial images 5–8 mm thick were obtained with breath-hold FFE T1W (TR = 110 ms, TE = 1.8 ms, FA = 80 $^\circ$ ), respiratory gated TSE T2W (TR = 4000 ms, TE = 180 ms, TF = 22), and breath-hold GRASE SPIR T2W (TR = 1387 ms, TE = 105 ms, TF = 12, EPI factor = 3; Fig. 2D) sequences. All MRI sequences confirmed the presence of a hypointense nodule.

Breath-hold diffusion-weighted (DW) images (TR = 2115 ms, TE<sub>d</sub> = 70 ms, *b* = 500) were also acquired and the apparent diffusion coefficient (ADC) map was calculated. The nodule appeared hypointense in DW (Fig. 2E) and ADC images. The ADC values were 0 within the lesion and  $0.90 \times 10^{-3} \text{ mm}^2/\text{s} \pm 0.25$  in the surrounding liver parenchyma.

The patient underwent mammography, CT of the thorax and pelvis, US of the neck, and measurements of principal serum markers to exclude malignancies. All examinations were negative.

Four months after the initial observation, a full biopsy of the lesion was performed under US guidance, with collection of two samples. The US appearance of the lesion had changed, consisting of a 15-mm targetlike nodule (Fig. 2B), with a hyperechoic core surrounded by a thin, well-defined hypoechoic ring.

The biopsy specimens were stained with hematoxylin and eosin, elastic van Gieson, and reticulin. Histologi-

cally, the lesion composed mainly of coagulative necrosis with a homogeneous periphery, and the central zone had a rough patchy appearance with cellular debris. The coagulative necrosis was surrounded by a thin boundary of collagen fibers with scanty mononuclear inflammatory cells and elastic fibers. No vessels were demonstrated. The hepatic tissue surrounding the lesion was normal (Fig. 2F). Special stains, such as Grocott, Ziehl–Neelsen, and periodic acid–Schiff, excluded bacterial, fungal, and parasitic infections. The final histopathologic diagnosis was SNN of the liver.

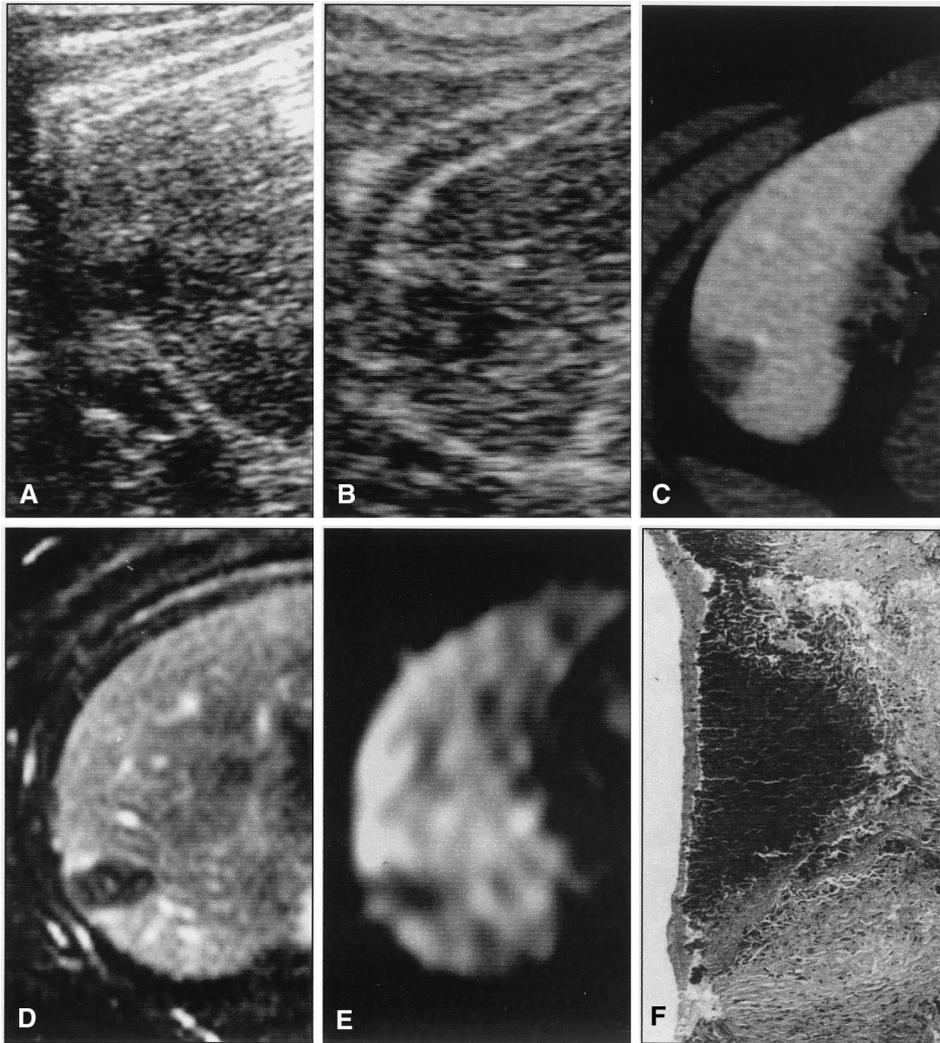
Due to the lack of signs of malignancies, surgery was not proposed to the patient. Three US and one MRI examinations over the following 12 months demonstrated no changes in size, morphology, and signal intensity of the lesion.

## Discussion

In 1983 Shepherd and Lee reported five cases of an unusual lesion of the liver characterized by a necrotic core surrounded by a dense collar of hyalinized collagen, incorporating elastic fibers [1]. Possible etiopathogeneses of the lesion include sclerosing hemangiomas, trauma, and sequelae of previous infections such as tuberculosis, syphilis, amoebiasis, and visceral larva migrans *Toxocara* and *Linguatula* [1–3].

To our knowledge, this is the first report combining US, CT, and MRI findings of two cases of SNN of the liver. All imaging features can be explained on the basis of histologic findings.

With regard to US, the nodule in case 1 and the nodule border in case 2 appeared hypoechoic due to homogeneity of the coagulative necrosis. In contrast, the central portion in case 2 was hyperechoic because of multiple interfaces in the rough patchy core, probably as a result of more rarefied zones of progressive dehydration. In our opinion, this progressive dehydration of the



**Fig. 2.** Case 2. **A** US of the liver shows a 15-mm hypoechoic nodular lesion resembling a secondary solitary mass in the subcapsular portion of segment VI. **B** Four months later, US shows a 15-mm targetlike lesion in the subcapsular portion of segment VI, with a central hyperechoic core surrounded by a peripheral hypoechoic ring. **C** Helical CT in the portal phase after intravenous administration of iodinated contrast material shows a nonenhancing hypodense nodular lesion in segment VI. **D** On a GRASE SPIR T2W image, the lesion appears as a small, strongly hypointense mass. **E** DW image ( $b = 500$ ) shows a hypointense nodule. **F** Biopsy specimen of the solitary necrotic nodule of the liver. Hematoxylin and eosin; original magnification, 40 $\times$ . The lesion is composed of a core of coagulative necrosis with a homogeneous periphery and a central zone with a rough patchy appearance and cellular debris. The core is surrounded by collagen fibers with scanty mononuclear inflammatory cells and elastic fibers. The hepatic tissue surrounding the lesion is normal.

eosinophilic core is responsible for the change of the US appearance of the nodule. The external capsule of collagen and elastic fibers observed at the pathologic examination probably were too thin to be detectable on US.

The lack of vascularity of the lesions is in line with the absence of enhancement in all CT contrast phases.

On MRI, the lesions were homogeneously hypointense in all sequences because of low hydration, vascularity, and cellularity due to coagulative necrosis [4], with no differences between the central and peripheral zones in case 2. The signal intensity was very low, even in the DW images. In our opinion, this was not determined by high diffusibility within the lesion but by the low content of free water and diffusible substrate, as confirmed by the low signal in the T2W images and the 0 ADC value. The latter MRI findings might be the most characteristic features of these lesions, which might differentiate SNN from other focal lesions of the liver.

In particular, the most important differential diagnosis of the US and CT patterns shown by SNN is the solitary

metastatic nodule. Other differential diagnoses include lymphoma, pseudotumor, regenerative and dysplastic nodules, and some infectious processes.

Metastatic disease and lymphoma have a wide range of signal and morphologic features and can present as a solitary lesion. Although hypoechoic nodules are the most frequent US aspect, a bull's-eye appearance can occur, especially in secondary masses. After intravenous administration of diffusible contrast material, metastases and lymphoma usually show some enhancement. Both usually have an intermediate to high signal on T2W MRI sequences. This MRI appearance is very useful for differentiating solitary metastasis and liver lymphoma from SNN. The only metastases that show very low T2 signal are those that have calcified and some varieties (melanin producing) of melanoma. However the former are easily differentiated from SNN because of their hyperdensity on plain CT, whereas the latter are recognizable from their high signal in T1W sequences (due to melanin, a superparamagnetic agent). Moreover, at variance with SNN,

hepatic metastases have higher signal intensities than normal liver parenchyma on DW images [5, 6].

In our opinion, the coagulative type of necrosis and the relative very low MRI signal in all sequences are the most particular features of the SNN. The only lesions characterized by this type of necrosis and MRI aspect are the nodules of hepatocellular carcinoma some months after treatment with percutaneous ethanol injection or radiofrequency ablation [4].

Further, the DW features of SNN remind us that a low “diffusion” signal does not always represent higher diffusibility [5] but may be the result of a reduction of the diffusible substrate, as occurs in the fatty or cirrhotic livers [5]. Therefore, ADC maps always should be calculated for a correct definition of the diffusion.

Pseudotumor hepatitis can show US and CT features resembling those of SNN, but, even in the late hyalinized phase, it appears as a slightly hyperintense mass in T2W sequences and shows a targetlike enhancement [7].

Regenerative liver nodules show low signal in T1 and T2 acquisitions, but usually there are several nodules without a bull’s-eye pattern on US. They develop mainly in cirrhotic livers, have a portal blood supply, and show enhancement during the portal venous phase [8]. Similar considerations apply to dysplastic nodules that are recognizable for their intermediate to high signal intensity in T1W sequences.

We have to consider some infectious processes as *Pneumocystis carinii*, histoplasmosis, and some Mycobacterium species, which can cause lesions with a bull’s-eye pattern on US and very low signals on T2W sequences without contrast enhancement. However, those infectious processes usually result in multiple lesions, often with small calcifications. Differential diagnosis with *Fungus hyphae* masses may be possible based on their

peripheral tiny enhancement ring and slight T2 hyperintensity of the borders.

## Conclusions

SNN of the liver is a benign lesion that must be considered in the differential diagnosis of focal liver masses. Its imaging features, when considered together, are peculiar. An hypoechoic nodule or a bull’s-eye lesion without contrast enhancement and with hypointense signal in all MRI sequences including DW images suggest a SNN. The most difficult and important differential diagnosis is with solitary metastasis and might require full biopsy or surgery.

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