Dokkyo Journal of Medical Sciences
39(1) : 85～89, 2012

Case Report

Measurement of Tissue Stiffness with Virtual Touch Tissue Quantification in Two Cases of Spleen Tumor

Dan Ichikawa, Shogo Adachi, Toru Kuniyoshi, Kazuyoshi Suzuki, Yasumi Katayama, Masaya Tamano

Department of Gastroenterology, Dokkyo Medical University Koshigaya Hospital

SUMMARY

We performed non-invasive measurement of tissue stiffness in the spleen for two patients using virtual touch tissue quantification (VTTQ). Case 1 was an 82-year-old woman with Hodgkin lymphoma. Stiffness measured using VTTQ was lower than normal spleen in tumor areas and higher than normal spleen in non-tumor areas. Case 2 was a 66-year-old man with ascites and gastric cancer involving the entire spleen. Stiffness of the spleen tumor as measured by VTTQ was higher than normal spleen. These cases demonstrated two new factors associated with elevated spleen stiffness : compression of healthy spleen tissue by tumor and cancer invasion.

Key Words : virtual touch tissue quantification, spleen, tissue stiffness

INTRODUCTION

Recent advances in ultrasound technology have enabled the non-invasive measurement of tissue stiffness in various organs. Virtual touch tissue quantification (VTTQ) is a new technique that can measure tissue stiffness by measuring the velocity at which shear waves produced by acoustic radiation force impulse (ARFI) are propagated in the tissue. Measurements are expressed as shear wave propagation velocity (VS) in meters per second (m/s), with higher VS indicating stiffer tissue. Measurements of liver stiffness with VTTQ are reported useful for evaluating liver fibrosis in chronic liver disease[1,2] and for distinguishing neoplastic liver tumors[3,4].

Received November 8, 2011 ; accepted December 28, 2011
Reprint requests to : Masaya Tamano
Department of Gastroenterology, Dokkyo Medical University Koshigaya Hospital
2-1-50 Minami-Koshigaya, Koshigaya-Shi, Saitama 343-8555, Japan

We measured stiffness with VTTQ and obtained interesting findings in two cases of spleen tumor. An ACUSON S2000 ultrasound system (Siemens Medical Solutions USA, CA, USA) was used. Spleen stiffness was measured 5-10 times at locations 2-4 cm from the body surface under B-mode ultrasonographic guidance, and expressed as mean ± standard deviation. Measurements of spleen stiffness were performed after obtaining approval from the Institution Review Board of Dokkyo Medical University Koshigaya Hospital and informed consent from both patients.

CASE 1

The patient was an 82-year-old woman who presented in May 2011 with a chief complaint of loss of appetite. Computed tomography (CT) showed enlargement of many cervical, supraclavicular, mediastinal, and intraperitoneal lymph nodes. The spleen was enlarged and many tumors with poor contrast enhancement were seen (Fig. 1). Hodgkin lymphoma was diagnosed from a biopsy of cervical lymph nodes. Many hypoechoic lesions were seen in the enlarged spleen

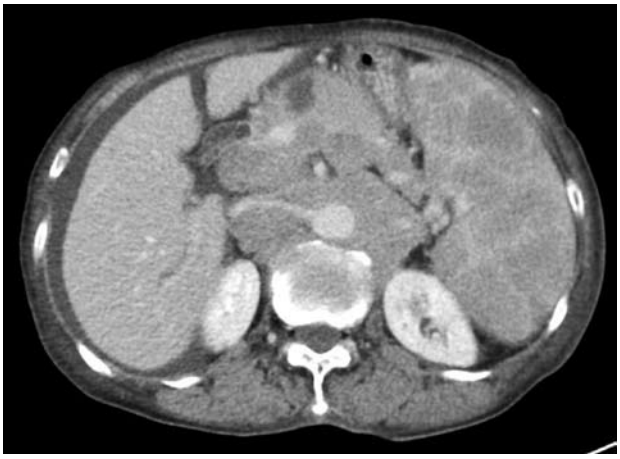

Fig. 1 On enhanced computed tomography (CT), the spleen is enlarged and many tumors of varying sizes and poor contrast enhancement are seen. Enlargement of many intraperitoneal lymph nodes and retention of a small amount of ascites are apparent.

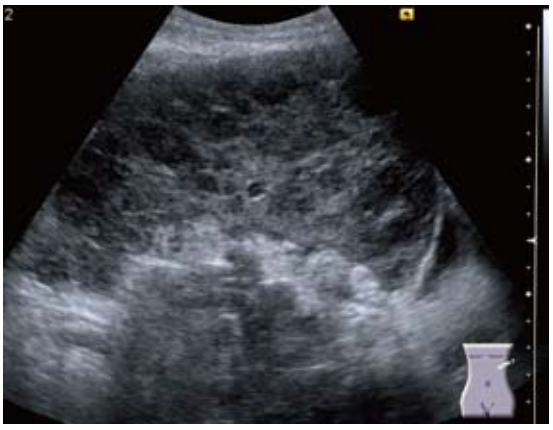

Fig. 2 Many hypoechoic tumors are evident in the enlarged spleen on abdominal ultrasound. Non-tumor portions appear hyperechoic area.

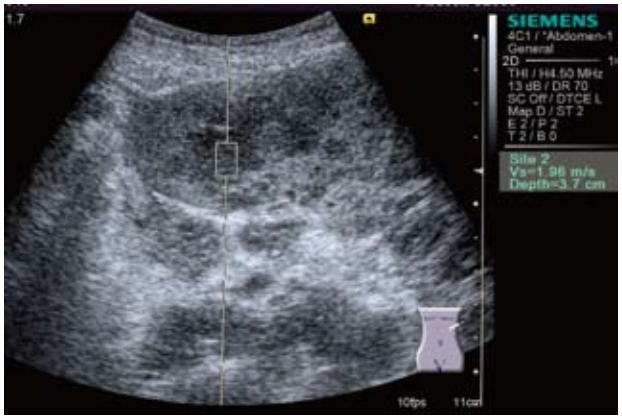

Fig. 3 Measurements of stiffness with virtual touch tissue quantification (VTTQ) were made at a depth of 3–4 cm from the body surface under B-mode ultrasonographic guidance.

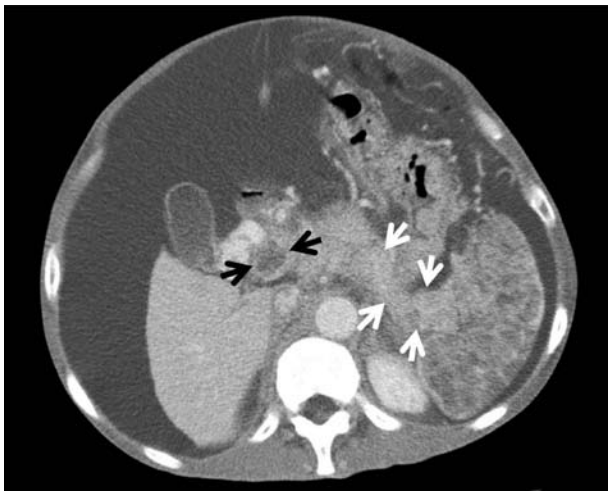

Fig. 4 A large amount of ascites is seen on enhanced CT. The entire spleen has become tumorous and tumor embolisms are apparent in the splenic vein (white arrow) and main trunk of the portal vein (black arrow).

on B-mode ultrasonography (Fig. 2). Stiffness measured using VTTQ was 1.78 ± 0.14 m/s in tumor areas and 3.77 ± 0.16 m/s in non-tumor areas (Fig. 3).

CASE 2

The patient was a 66-year-old man who was admitted in June 2011 for a thorough examination of ascites. On CT, the spleen was enlarged and the entire spleen had become tumorous. A tumor thrombus that continued from the splenic vein to the main trunk of the portal vein was identified (Fig. 4). Thickening of the gastric wall around the entire circumference was also evident, and continuity was seen between the thickened gastric wall and spleen (Fig. 5). The primary lesion was diagnosed by endoscopy and biopsy as gastric cancer (moderately differentiated adenocarcinoma). No lung, lymph node, or peritoneal metastases were identified. The ascites was transudative, and carcinomatous peritonitis was denied by cytological diagnosis. The diagnosis was portal vein tumor embolism resulting from direct invasion of gastric cancer into the spleen, and production of ascites from portal hypertension. On B-mode ultrasound, the entire area of the spleen was diagnosed to be tumorous, with no

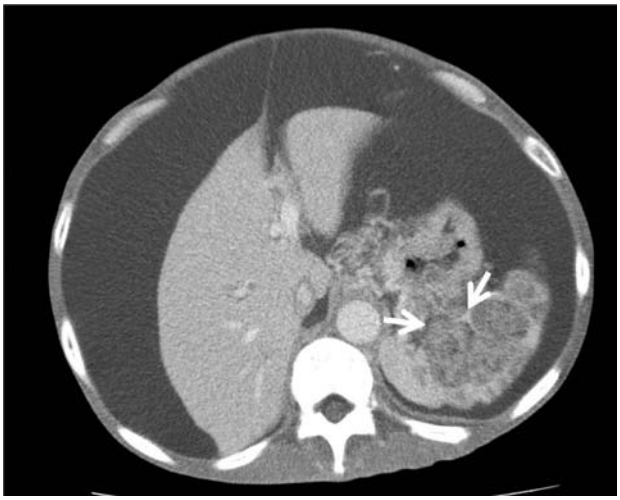

Fig. 5 Contrast-enhanced CT shows continuity of the spleen tumor and thickened gastric wall (white arrow).

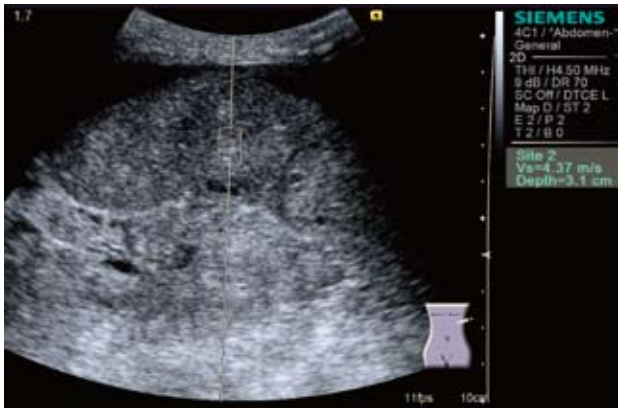

Fig. 6 Measurement of spleen tumor stiffness with VTTQ was made using the same method as in Case 1.

non-cancerous areas of splenic parenchyma apparent. Stiffness of the spleen tumor as measured by VTTQ was 4.05±0.47 m/s (Fig. 6).

DISCUSSION

Many splenic lesions related to malignant lymphoma are seen, but few investigations of ultrasonographic findings for these lesions have been reported. Goerg et al. described abnormal splenic findings on ultrasonography in 43 of 900 patients (4.8%) with malignant lymphoma[5]. Sixteen of those patients had Hodgkin lymphoma, with focal ultrasound findings in 7 and diffuse findings in 9. When lesions are focal, the tumor is observed as a hypoechoic lesion. The splenic lesion in Case 1 corresponded with this focal type.

Cancer metastasis to the spleen is rare, occurring in 0.6-7.1% of all cancer cases according to autopsy investigations[6~8]. Metastasis of gastric cancer to the spleen has been found to be relatively high, at 7-16 %[7,8]. However, patients with metastasis to the spleen have many metastases to multiple organs[6], and the spleen is generally the last organ to show hematogenous metastasis of cancer[9]. Case 2 was a rare case in which no distant metastases were identified and the cancer invaded the spleen directly.

In 2003, Sandrin et al. reported the usefulness of liver stiffness measurements with transient elastography in diagnosing fibrosis of the liver in chronic hepatitis C patients[10]. Transient elastography is an ultrasound-based technology that measures liver stiffness using differences in the velocity of elastic shear wave propagation across the liver. This new test method is useful in diagnosing chronic liver disease including non-alcoholic steatohepatitis[11] and hepatocellular carcinoma[12~14], as well as in predicting the development of cancer[15~17]. However, transient elastography is a technique that blindly measures sites marked on ultrasound images, so measurement of stiffness in places other than the right lobe of the liver is difficult. Transient elastography also has the disadvantage of being unable to make measurements when substantial amounts of ascites or adipose tissue are present between the probe and liver. VTTQ can measure stiffness while checking the image in real time with ultrasound monitoring. In addition, shear waves produced by ARFI can be generated laterally at any depth on the observed plane. Using VTTQ thus allows the measurement of stiffness in the left lobe of the liver[18] and other peritoneal organs that are difficult to measure with transient elastography[19].

Few reports have described the measurement of stiffness using VTTQ in organs other than the liver. Gallotti et al. measured stiffness of peritoneal organs in healthy people, and reported mean values of 1.59 m/s for the liver, 1.40 m/s for the pancreas, 2.44 m/s for the spleen, and 2.24 m/s for the kidney[19]. The highest stiffness was thus seen in the spleen. We found a spleen stiffness of 2.37±0.25 m/s in an investigation of 10 healthy volunteers (data not shown), similar to the results of Gallotti et al.

Of the two cases reported here, Case 1 showed

splenic metastasis of Hodgkin lymphoma. Stiffness of the tumor portion was lower than the stiffness of the spleen in healthy people, while that in the non-tumor portion was higher. In routine medical care, lymphoma often seems softer than cancer or inflammatory tumors, but we have seen no reports of stiffness measured using VTTQ. In Case 1, stiffness of the non-tumor portion was elevated, which was attributed to increased density in the spleen due to pressure on structural components from the tumor. Case 2 involved spleen metastasis of gastric cancer. The entire spleen appeared tumorous on CT and ultrasound examinations, so stiffness of non-tumorous spleen could not be measured. However, stiffness of the tumorous spleen was extremely high.

In cases of chronic hepatitis or cirrhosis, stiffness of the spleen reflects fibrosis of the liver and thus increases[2]. Measurements of spleen stiffness are thus thought to be useful in predicting esophageal varices[20]. The elevated pressure in the spleen resulting from congestion caused by increased splenic blood flow due to portal hypertension, as well as fibrosis of the spleen, are thought to contribute to increased spleen stiffness in chronic liver disease, although the details remain unclear. The present study identified two new factors associated with elevated spleen stiffness : invasion of cancer and compression of healthy spleen tissue by tumor. The objective finding of low stiffness for lymphoma compared with cancer was also very interesting.

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