CLINICAL STUDY

Changes in Liver Congestion in Patients with Budd–Chiari Syndrome following Endovascular Interventions: Assessment with Transient Elastography

Amar Mukund, MD, Sudheer S. Pargewar, DMRD, DNB, PDCC, Saloni N. Desai, MD, DNB, PDCC, S. Rajesh, MD, PDCC, and Shiv K. Sarin, MD, DM

ABSTRACT

Purpose: Transient elastography (TE) is routinely used for noninvasive staging of hepatic fibrosis. The objective of the present study was to investigate the role of TE (FibroScan) in determining changes in liver congestion in patients with Budd–Chiari syndrome (BCS) treated by endovascular interventions and determine the effects of pretreatment Meta-analysis of Histological Data in Viral Hepatitis (METAVIR) fibrosis score on posttreatment liver stiffness (LS).

Materials and Methods: Twenty-five patients undergoing endovascular procedures for treatment of BCS underwent TE immediately before and within 24 hours after the procedure. Fifteen patients available for 3-month follow-up were again subjected to TE. Mean LS values before and after intervention were compared in 12 of these patients for whom METAVIR scores were available. Pressure gradient changes across the stenosed hepatic veins/inferior vena cava were measured during the procedure. Statistical analysis of these data was performed by Wilcoxon signed-rank test, Mann–Whitney *U* test, and Pearson product–moment correlation coefficient.

Results: Significant differences were found between mean LS measurements before and within 24 hours after intervention (Z-score = 4.372) and between the mean values obtained before and 3 months after treatment (Z-score = 3.408). Mean changes in LS values after intervention in patients with METAVIR fibrosis scores ≤ 2 and > 2 were not significant. There was no correlation between changes in pressure gradients and the degree of LS.

Conclusions: TE is a useful tool to assess the reduction in hepatic congestion in patients with BCS undergoing endovascular interventions.

ABBREVIATIONS

BCS = Budd–Chiari syndrome, DIPS = direct intrahepatic portosystemic shunt, HV = hepatic vein, IVC = inferior vena cava, LS = liver stiffness, METAVIR = Meta-analysis of Histological Data in Viral Hepatitis, TE = transient elastography, TIPS = transjugular intrahepatic portosystemic shunt

The term Budd–Chiari syndrome (BCS) is applied to a diverse group of conditions caused by hepatic venous outflow obstruction at the level of the large hepatic veins (HVs) or the suprahepatic segment of the inferior vena cava (IVC) (1). It results in venous stasis, portal hypertension, and reduction of portal perfusion causing ischemic injury to hepatocytes and resultant hepatic cell inflammation (2). These biologic factors, ie, hepatocyte inflammation and hepatic congestion, contribute to increased liver stiffness (LS) (3). LS can be assessed by elastographic techniques such as strain imaging (static or quasistatic) or shear-wave imaging (dynamic), which includes one-dimensional transient elastography (TE), point/shear-wave elastography, acoustic radiation force impulse imaging, and continuous magnetic resonance elastography (3–5). One-dimensional TE is the

From the Departments of Radiology (A.M., S.S.P., S.N.D., S.R.) and Hepatology (S.K.S.), Institute of Liver and Biliary Sciences, D-1, Vasant Kunj, New Delhi, 110070, India. Received February 29, 2016; final revision received November 14, 2016; accepted November 28, 2016. **Address correspondence to** A.M.; E-mail: dramarmukund@gmail.com

None of the authors have identified a conflict of interest.

http://dx.doi.org/10.1016/j.jvir.2016.11.091

first elastography technique developed to noninvasively assess the stiffness of deep soft tissues such as the liver (6).

The main goal of treatment in patients with BCS is to alleviate hepatic congestion, thereby improving hepatocyte function and allowing resolution of portal hypertension, and TE can be used to measure this hepatic congestion (6,7). The aims of the present study were to evaluate the efficacy of endovascular treatment for BCS by determining the change in LS following endovascular procedures and to determine the effect of the pretreatment Meta-analysis of Histological Data in Viral Hepatitis (METAVIR) fibrosis score on posttreatment LS by using TE.

MATERIALS AND METHODS

The study was performed in accordance with the principles of the Declaration of Helsinki and was approved by the institutional review board. Twenty-five patients with clinical, biochemical, radiologic, or histologic diagnosis of acute or chronic BCS treated with endovascular interventions were included in this study. Patients with obesity (body mass index > 30 kg/m^2), metabolic syndrome, liver lesions, or cholestasis were excluded to reduce the confounding factors affecting LS. Patients with absolute contraindications to endovascular procedures or end-stage liver disease were not included. Demographic data and liver function test results before the intervention are shown in Table 1. Twelve of these 25 patients underwent transjugular/percutaneous liver biopsy before the procedure. These biopsy samples were analyzed histopathologically for the presence of fibrosis and were scored according to the METAVIR scoring system (8).

Various endovascular interventions were performed, including HV angioplasty and stent implantation (n = 14), direct intrahepatic portosystemic shunt (DIPS) creation (n = 4), IVC angioplasty (n = 3), HV angioplasty without stents (n = 1), DIPS creation with IVC stent implantation (n = 1), HV stent implantation with IVC angioplasty (n = 1), and transjugular intrahepatic portosystemic shunt (TIPS) creation (n = 1). At the end of the procedure, pressure gradients were measured across the treated hepatic venous outflows in patients who underwent balloon angioplasty and stent implantation. In patients treated with HV angioplasty and/or stent implantation, pressure gradients were measured across the stenosed HV segment between the patent distal HV segment and the IVC or right atrium by using 4-F or 5-F multipurpose catheters. In patients with IVC occlusion or stenosis, gradients were measured across the patent segment of the IVC and right atrium. Portosystemic gradients were measured in patients after DIPS or TIPS creation. The results of treatment were assessed for anatomic, hemodynamic, clinical, and hematologic responses (Table 2).

Table 1. Demographics and Liver Function Test Results of Study Population

Characteristic	Patients (n = 25)
Sex (M/F)	15/10
Age (y)	
Range	7–56
Mean ± SD	30.96 ± 11.22
Total bilirubin (mg/dL)	1.76 ± 1.08
AST (×ULN)	1.17 ± 0.42
ALT (×ULN)	0.96 ± 0.39
ALP (×ULN)	1.44 ± 0.61
GGT (×ULN)	1.49 ± 1.13

Note–Values presented as mean ± SD where applicable.
ALP = alkaline phosphatase; ALT = alanine aminotransferase; AST = aspartate aminotransferase; GGT = γ-glutamyltranspeptidase; SD = standard deviation; ULN = upper limit of normal.

LS Measurement Technique

All 25 patients underwent TE with the use of a FibroScan ultrasound (US) unit (Echosens, Paris, France) performed by two trained operators with a minimum experience of 3 years (success rate of $> 60\%$ with a target of achieving ≥ 10 successful readings). Paracentesis was performed in patients who had significant ascites before the FibroScan examination. TE was performed immediately before the interventional procedure and again within 24 hours. Fifteen patients available for 3-month follow-up were again subjected to a FibroScan TE procedure. LS measurements were taken from the right hepatic lobe. A 3.5-MHz US transducer mounted on the axis of a vibrator was placed in a right intercostal space with the patient lying supine and the right arm in abduction. A 50-Hz vibration with amplitude of 2 mm and pulse tracking frequency of 3.5 MHz, yielding a window depth of 20–60, mm was propagated into the liver as elastic shear waves. Ten successful measurements were obtained in every patient, and the mean LS value was calculated in kilopascals.

Statistical Analysis

Results are expressed as mean, median, standard deviation, and standard error. The Wilcoxon signed-rank test was used to calculate the statistical significance between the differences in LS values before and after the endovascular procedure. P values of less than .05 were considered statistically significant. The results are illustrated as the median and 25th- to 75th-percentile values in box plots. The correlations between the changes in pressure gradients across the stenosed HVs/IVC and LS measurements after interventional procedures were also assessed by Pearson correlation coefficient.

Based on the METAVIR fibrosis scores of the 12 patients in whom biopsy was performed before the intervention, these patients were divided into two groups: those with a fibrosis score ≤ 2 and those with a fibrosis score > 2. The differences in changes in LS measurements after interventional procedures between