EUS-guided portal pressure gradient measurement with a novel 25-gauge needle device versus standard transjugular approach: a comparison animal study

Jason Y. Huang, FRACP, Jason B. Samarasena, MD, Takeshi Tsujino, MD, Kenneth J. Chang, MD

Orange, California, USA

Background and Aims: Portal hypertension (PH) is a serious adverse event of liver cirrhosis. The hepatic venous pressure gradient (HVPG) accurately reflects the degree of PH and is the single best prognostic factor in liver disease. Currently, portal pressure gradient (PPG) measurement is performed at interventional radiology (IR) with a standard transjugular approach requiring radiation and intravenous contrast. The aim of this study was to develop a novel EUS-guided system using a 25G FNA needle and compact manometer to directly measure PPG and to evaluate its performance and clinical feasibility.

Methods: Experiments were performed in 3 swine that were under general anesthesia. Manometry was performed in venous (baseline and PH) and arterial (aorta) systems. The PH model was created by rapid Dextran-40 infusion peripherally. Under EUS guidance a 25G FNA needle with attached manometer was used to puncture (transgastric-transhepatic approach) and measure pressures in the portal vein, right hepatic vein (RHV), inferior vena cava (IVC), and aorta. With the IR approach, RHV (free and wedged), IVC, and aorta pressure were measured with an occlusion balloon. Pressure correlation was divided into 3 groups; low pressure (baseline), medium pressure (noncirrhotic portal hypertensive model), and high pressure (arterial). Correlation between the 2 methods of measurement was charted in scatter plots, and the Pearson's correlation coefficient (R) was calculated.

Results: EUS identification, access, and manometry was successful in all targeted vessels. There was excellent correlation (R, .985-.99) between EUS and IR methods in all pressure ranges. No adverse event occurred.

Conclusions: This novel technique of EUS-PPG measurement using a 25G needle and novel manometer was feasible and demonstrated excellent correlation with the standard transjugular method throughout low, medium, and high pressure ranges.

Portal hypertension (PH) is a serious adverse event of liver cirrhosis.[1] Patients with PH are at risk of developing gastroesophageal varices and related bleeding, ascites, hepatorenal syndrome, and hepatic encephalopathy.[2] The hepatic venous pressure gradient (HVPG) accurately reflects the degree of PH in all forms of sinusoidal and postsinusoidal causes. Knowing the HVPG can guide medical therapy, assess the degree of liver fibrosis,[3] and predict risk of decompensation and developing hepatocellular carcinoma.[4,5] However, the transjugular procedure to obtain the HVPG is invasive and not readily available; therefore, most patients with suspected PH do not undergo this procedure.

Older studies have been conducted examining the feasibility of EUS-guided portal vein pressure (PVP) measurements. These studies have used 5.5F catheters[5] and

Abbreviations: HV, hepatic vein; HVPG, hepatic venous pressure gradient; IR, interventional radiology; IVC, inferior vena cava; PH, portal hypertension; PPG, portal pressure gradient; PV, portal vein; PVP, portal vein pressure; RHV, right hepatic vein.

DISCLOSURE: *The following authors disclosed financial relationships relevant to this publication, however for the purpose of this study, no financial support was issued: J. Y. Huang, K. J. Chang: Consulting and financial support from Cook Medical; J. B. Samarasena: Financial support from Cook Medical; K. J. Chang: Lecturer for Cook Medical. All other authors disclosed no financial relationships relevant to this publication.*

0016-5107/$36.00
http://dx.doi.org/10.1016/j.gie.2016.02.032

Received November 25, 2015. Accepted February 19, 2016.

Current affiliation: H.H. Chao Comprehensive Digestive Disease Center, University of California, Irvine Medical Center, Orange, California, USA.

Reprint requests: Kenneth Chang, Department of Gastroenterology, University of California Irvine Medical Center, 101 The City Dr. Blvd., Orange, CA 92686.

If you would like to chat with an author of this article, you may contact Dr Chang at kchang@uci.edu.

22-gauge (G) FNA needles[6] and have been based on direct PVP measurement. These studies used complex setups with fluid-filled manometers, and no studies measured the portal pressure gradient (PPG), that is, the pressure differential between the portal vein (PV) and inferior vena cava (IVC) or hepatic vein (HV).

Here we present the first study of EUS-guided PPG measurement with a novel simplified technique using a 25G needle and compact manometer (Fig. 1) with simultaneous correlation to the current criterion standard, transjugular free, and wedged hepatic venous pressure. Feasibility and accuracy of this novel technique and setup were evaluated in a porcine model with and without PH.

METHODS

Animal model

Three Yorkshire swine weighing 43.5 to 48 kg were sedated with Telazol/xylazine (Zoetis, Florham Park, NJ) followed by intubation and maintained in supine position with isoflurane. Continuous monitoring for heart rate, respiratory rate, end-tidal CO_2, and oxygen saturation was carried out throughout the experiment until the swine were killed with pentobarbital/phenytoin. Pressure measurements were carried out at baseline hemodynamics and then postinduction of noncirrhotic PH by rapid peripheral infusion of Dextran-40 ($\leq$1.5 L). This study protocol was approved by the hospital's Institutional Animal Care and Use Committee.

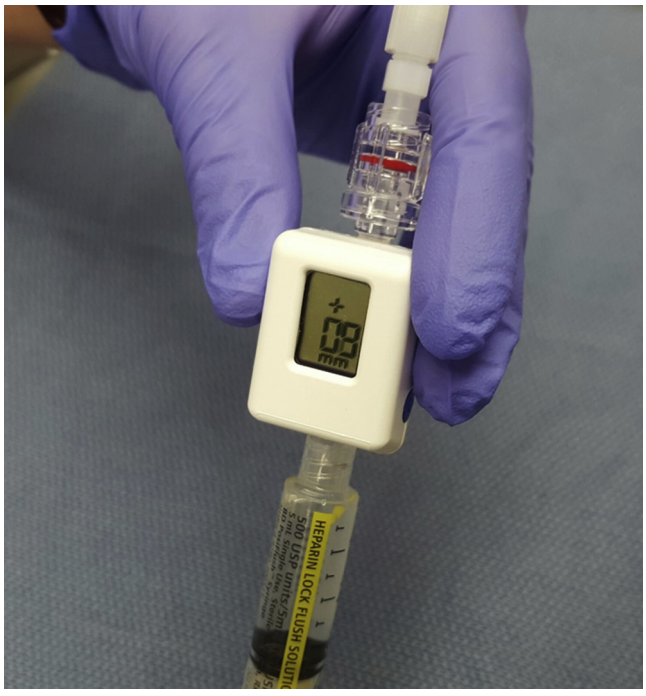

Figure 1. Compact pocket-sized battery-operated manometer.

EUS procedure

A linear echoendoscope (GF-UC140P-AL5; Olympus, Tokyo, Japan), 25G FNA needle (Cook Medical, Winston-Salem, NC), manometer, and noncompressible tubing (Cook Medical, Bloomington, Ind) were used. Measurements were conducted in the right hepatic vein (RHV), PV, IVC, and aorta. All venous measurements were performed via the transgastric transhepatic approach (Fig. 2). When evaluating RHV pressure, FNA needle placement was targeted at 2-cm distal to the ostia. When targeting the left main PV, only the intrahepatic portion near the PV bifurcation was accessed. IVC was accessed at the level of the RHV ostia, and the aorta was accessed just above the coeliac takeoff. Up to 1 mL heparinized saline solution was flushed through the FNA needle before each EUS reading. After 30 to 60 seconds of stabilization, the pressure was recorded, and generally $\geq$3 separate readings per vessel per FNA were performed. Transjugular and EUS pressure transducers were zeroed at an identical level (mid-axillary line).

Interventional radiology procedure

Manometric data were obtained from the RHV (both free and wedged), IVC, and aorta. External jugular venous cutdown facilitated venous access, whereas aortic pressure (at the level just above coeliac takeoff) was obtained via the femoral artery. A 5F 11-mm balloon occlusion catheter connected to a pressure transducer and recorder was used. Calibration was performed at 6.8 cm (5 mm Hg), 13.6 cm (10 mm Hg), and 20.4 cm (15 mm Hg) of water.

Correlation

In the RHV, IVC, and aorta the transjugular balloon catheter tip and FNA needle tip were targeted at the exact same

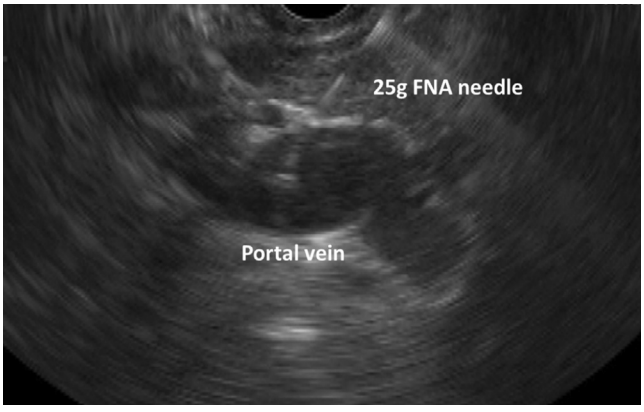

Figure 2. Transgastric transhepatic EUS placement of 25G needle into the left main portal vein.