EUS-Guided Portal Pressure Gradient Measurement

INTRODUCTION

Portal hypertension (PH) is a serious complication of cirrhosis. Survival in cirrhosis is related to the presence of hepatic decompensation, with survival markedly reduced when decompensation occurs. PH is the cause of many of the major complications of liver disease such as ascites, variceal hemorrhage, hepatic encephalopathy, hepatocellular carcinoma and death.

Measurement of the hepatic venous pressure gradient (HVPG) or portal pressure gradient (PPG) accurately reflects the severity of PH. The PPG is the single best prognostic factor in liver disease. As such, PPG can inform and guide medical therapy as well as predict liver decompensation and risk of hepatocellular carcinoma (HCC).

A HVPG > 5 mm Hg defines PH. HVPG between 6-9 mm Hg is considered mild PH whereas greater than or equal to 10 mm Hg is considered clinically significant portal hypertension (CSPH). An HVPG > 9 mm Hg predicts cirrhosis.

When the HVPG is greater than or equal to 12 mm Hg, the risk of acute variceal hemorrhage (AVH) is increased. A HVPG greater than or equal to 16 mm Hg is associated with a significantly increased risk of hepatic decompensation (HD) and death. Clinically significant portal hypertension (CSPH) increases risk of early mortality after emergency surgery. In patients with a HVPG >10 mm Hg there is a six-fold increase in the risk of HCC. A HVPG < 10 mm Hg in a patient with compensated cirrhosis is associated with a 90% probability of not developing HD in a median follow up of four years. A HVPG greater than or equal to 20 mm Hg in a patient with compensated cirrhosis independently predicts early and more frequent HD and poorer outcomes, such as failure.
to control bleeding, early rebleeding, and death during AVH. For every 1 mm Hg increase in HVPG, there is a 3% increased risk of mortality independent of the patient’s MELD score. For example, a patient with cirrhosis with a HVPG of 15 mm Hg has a 30% higher mortality risk over a patient with HVPG of 5 mm Hg. Moreover, HVPG may be helpful in identifying patients with intermediate MELD scores who should be considered for early liver transplantation due to higher mortality risk than predicted by MELD alone. As such, it is often important to know the actual HVPG in patients with cirrhosis, as it can guide therapy and help predict clinical outcomes.

**Traditional Transjugular Hepatic Venous Pressure Gradient Measurement**

Interventional radiologists have traditionally performed HVPG measurements by transjugular approach. Under local anesthesia, with or without sedation, a catheter introducer is placed into the right internal jugular vein and, with contrast under fluoroscopic guidance, is advanced into the inferior vena cava (IVC). The balloon is positioned into a large hepatic vein (HV) as confirmed with injection of contrast media. The balloon is inflated, blocking the outflow of the cannulated HV. A transducer is attached to the system. A series of three pressure measurements are obtained of the wedged hepatic venous pressure (WHVP) and free hepatic venous pressure (FHVP). The difference between the WHVP and FHVP is referred to as the hepatic venous pressure gradient (HVPG), a surrogate of portal pressure, though not a direct measurement of PPG.

Using the same venous access, liver biopsy can be performed. Under fluoroscopy a needle introducer sheath is passed into the hepatic vein and a biopsy needle is advanced into the liver parenchyma to obtain an aspiration or core biopsy of liver. Disadvantages of the transjugular approach include patient discomfort from jugular vein puncture, the necessity of exposure to ionizing radiation, and the fact that it is an indirect measurement of portal vein pressure.

**Description of EUS PPGM Procedure**

An alternative approach to transjugular HVPG measurement is the endoscopic ultrasound (EUS)-guided approach to measuring the portal pressure gradient. (Figure 1) The portal pressure gradient measurement (PPGM) is obtained by EUS guided needle puncture through the liver parenchyma into a hepatic vein branch and the portal vein. Direct pressure measurements obtained from the portal vein (PV) and the hepatic vein (HV) can be obtained through the EUS needle utilizing a self-calibrating compact pressure transducer with

![Figure 1a. EUS image showing a nodular liver consistent with cirrhosis](image)

![Figure 1b. Pulse wave doppler showing tetraphasic waveform in hepatic vein branch](image)
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Figure 1c. Image of 25g needle in hepatic vein branch

![Figure 1c](image1)

Figure 1d. Pulse wave doppler showing monophasic waveform in the portal vein

![Figure 1d](image2)

Integrated digital display (Compass CT, Centurion Medical Products Corp). A Cook EchoTip Insight 25-gauge EUS needle (Cook Endoscopy, Winston Salem NC) with 5.2 French sheath, transducer, and 90 cm non-compressible tubing with stopcock, come prepackaged together.

An esophagogastroduodenoscopy (EGD) is performed first to screen for esophageal varies (EV) and portal hypertensive gastropathy (PHG). This is followed by an EUS exam looking for signs of liver disease such as blunting of the liver edge, liver nodularity, the presence of ascites and varices not appreciated on the EGD exam or other imaging studies, as well as liver evaluation for the presence of focal liver lesions.

During the EUS exam the endosonographer identifies an optimal HV branch and the PV. HV branches are more proximal. The IVC is easily identified in the cardia region of the stomach. The right hepatic vein (RHV) comes off the IVC first and is seen from the proximal stomach. The MHV branch comes off the IVC confluence with a typical “elephant trunk” appearance, uniform along its length and is often the best branch of the HV to target. The LHV is seen by EUS more distally in the stomach. The hepatic vein branches have a classic pulsatile four phase (multiphase) flow pattern on doppler. The PV has more hyperechoic walls and a monophasic venous “hum” pattern on doppler flow. The umbilical portion of left PV with typical “fish-eye” appearance and the ligamentum teres and ligamentum venosum arising on each side is usually most easily targeted.

Once preliminary EGD and EUS exam have been performed and the decision is made that PPGM can be performed, the Pressure Gradient Measurement System is prepared. During this time, sheer wave elastography (SWE) of the liver can be performed by positioning the probe over the region of interest avoiding vessels and taking an average of 10 measurements. SWE can predict fibrosis. Typically, liver biopsy (EUS-LB) is performed after PPGM.

Once the system is set up with non-compressible tubing flushed with heparinized saline it is attached to the FNA needle. With the patient in supine position, the transducer is gently held by the assistant at the patients left side, generally around axilla and at the level of the patient’s heart. Care should be taken by the assistant to not put any pressure on the back of the syringe during the pressure measurements and maintain the transducer in a stable and consistent level position throughout the procedure.

The liver parenchyma is punctured with the EUS needle and directed into the center of the HV or the PV. Heparinized saline is flushed through the tubing and bubbles observed within the vessel lumen. There is typically a rise or bump in pressure followed by steady drop until a steady
state pressure measurement is achieved over one minute. An average of a series of three sequential readings is taken, ignoring any widely discrepant readings.

As the needle is withdrawn out of the liver, doppler flow is used to confirm no bleeding from the needle tract or the surface of the liver. The EUS scope is repositioned to identify the next target vessel.

After completing PPGM, EUS-LB can be performed, the left lobe from transgastric approach and if desired the right lobe from transduodenal approach. Liver core samples are expressed onto filter paper or gauze and transferred to a formalin container to send to pathology. We perform EUS-LB with a 19-gauge FNB needle using wet suction technique using heparinized saline with one pass with 1-3 actuations into one or both lobes of the liver.

**Published Results to Date**

High success rates for PPG measurement have been achieved with no reports of major adverse events, although data on EUS-PPG measurements are limited at this time. In a multicenter study of 49 patients a 100% success rate was achieved with no major adverse events. Higher mean PPGs were found in patients with clinical portal hypertension including EV, PHG and thrombocytopenia. Patients with PPG > 5 mm Hg were 10 times more likely to have advanced fibrosis on liver histology and 13 times more likely if PPG was >10 mm Hg.

**Risk of Adverse Events**

EUS-PPGM involves the usual risks of sedated endoscopic exam and EUS-FNA and EUS-LB may be less painful and yield a greater number of portal tracts than percutaneous liver biopsy. EUS-LB allows sampling of both lobes of the liver. The risk of adverse events for patients undergoing EUS-LB is approximately 2.9%, lower with 19 gauge needle. No major adverse events have been reported with EUS PPGM. Samarasena et al. reported no major early or late adverse events in a series of 76 patients undergoing EUS-PPG measurement and EUS-LB. Mild post procedure pain has been
reported following EUS-PPGM and EUS-LB.

Relative contraindications to EUS-PPG include platelet count <50,000, INR >2, antiplatelet therapy, systemic anticoagulation, and large volume ascites that precluded safe needle access to the liver and the hepatic vasculature, although many patients with some degree of ascites can undergo the procedure. Antibiotic prophylaxis is recommended.

**CONCLUSION**

EUS-PPGM is a safe, easy, and effective system to assess patients with known or suspected liver disease. Moreover, the “one-stop shop” service to assess for EV and PHG, perform elastography and EUS-LB is attractive and may drive both acceptance and demand.

**References**


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24. EUS-GUIDED PORTAL PRESSURE GRADIENT MEASUREMENT SAFELY PERFORMED WITH EUS-GUIDED LIVER BIOPSY: ENDOHEPATOLOGY IN PRACTICE. Samarasena, Jason et al. Gastrointestinal Endoscopy, Volume 91, Issue 6, AB268 - AB269


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Answers to this month’s crossword puzzle:

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1. PRO T0N
2. AV I
3. SQ UAMOUS
4. N S PH I
5. ER I
6. T E R I
7. N P O T E T T E
8. MAC R O PH AGE
9. S E R T S
10. C O H O RTS
11. S T I T IC
12. W A T E R
13. B R I N G E
14. R U B I N
15. G L Y C E R O L
16. D U S E C E S
17. E S O P H AGE AL
18. N I C E
19. S C A R
20. U N I C E
21. M E T H O N
22. A N A O
23. T R E P H I N E
24. T E R A
25. E R I
26. N P O T E T T E
27. MAC R O PH AGE
28. S E R T S
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31. W A T E R
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48. R U B I N
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50. D U S E C E S
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