

Free Hepatic Vein Pressure Is Not Useful to Calculate the Portal Pressure Gradient in Cirrhosis: A Morphologic and Hemodynamic Study

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ABSTRACT

Purpose: To systematically evaluate the accuracy of free hepatic vein pressure (FVHP), the internal reference for hepatic venous pressure gradient (HVPG).

Materials and Methods: Diameter and pressure measurements were obtained in multiple locations within the hepatic vein, inferior vena cava (IVC), and right atrium on 30 hepatic venograms in 29 consecutive candidates for transjugular intrahepatic portosystemic shunt creation.

Results: On angiography, 15 patients (52%) had hepatic veins showing a normal and conical appearance, whereas the other 14 had irregular or narrow (maximal diameter ≤ 6 mm) veins. Diameters of hepatic veins increased from $4.4 \text{ mm} \pm 0.9$ (range, 3.3–7 mm) at a peripheral position to $8.7 \text{ mm} \pm 3.0$ (range, 5.0–15.5 mm; $P < .001$) at a central position, and respective pressures decreased from $10.9 \text{ mm Hg} \pm 3.7$ (range, 3–17 mm Hg) to $7.4 \text{ mm Hg} \pm 3.7$ (range, 0–14 mm Hg; $P < .001$). Gradients between wedged hepatic vein pressure and central free hepatic vein, IVC, and right atrium pressures were $17.2 \text{ mm Hg} \pm 5.4$ (range, 4–33 mm Hg), $18.0 \text{ mm Hg} \pm 5.8$ (range, 4–33 mm Hg), and $20.0 \text{ mm Hg} \pm 5.9$ (range, 4–33 mm Hg), respectively. Pearson correlation coefficients were 0.679 between the HVPG and hepatic atrial pressure gradient (HAPG) and 0.889 between the wedged hepatic vein/IVC pressure gradient (HCPG) and HAPG.

Conclusions: FVHP measurement depends on catheter tip position and vein morphology. Its use to calculate HVPG is not recommended. The high agreement between the HCPG and the HAPG suggests that both gradients may be used if one considers a systemic difference of 2 mm Hg.

ABBREVIATIONS

FHVP = free hepatic vein pressure, HAPG = hepatic atrial pressure gradient, HCPG = wedged hepatic vein/inferior vena cava pressure gradient, HVPG = hepatic venous pressure gradient, ICC = intraclass correlation coefficient, IVC = inferior vena cava, TIPS = transjugular intrahepatic portosystemic shunt, WHVP = wedged hepatic vein pressure

The hepatic venous pressure gradient (HVPG), the difference between the wedged hepatic vein pressure (WHVP) and the free hepatic vein pressure (FHVP), has gained increasing importance in quantifying the effect of vasoactive agents (1,2), identifying the

prognosis (3–6) and the need for early transjugular intrahepatic portosystemic shunt (TIPS) creation (7) in patients with acute variceal bleeding. Instructions on the measurement of the HVPG recommend that the FHVP should be measured close to the hepatic vein orifice

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within a distance of 4–5 cm of the inferior vena cava (IVC) (8,9). In case of a greater difference between measurements in the hepatic vein and the IVC (> 1 or 2 mm Hg), the latter pressure should be used (8,9). According to these recommendations, one may conclude that the pressure measured in the IVC at the level of the entrance of the hepatic veins is the more reliable measure that should be used in any case with a doubtful free hepatic vein measurement. The use of the right atrial pressure as a reference has been abandoned because it may not adjust changes in intraabdominal pressure (10).

Despite the widespread use of the HVPG, its reevaluation is required for several reasons. (i) In patients with advanced cirrhosis, hepatic veins may be narrow, irregular, or compressed. This may result in erroneous measurements with an apparently high FHVP and a low HVPG. (ii) In patients undergoing TIPS creation, postprocedural measurement of the FHVP is difficult or impossible. Therefore, measurements are commonly performed in the IVC or right atrium. (iii) The right atrium is the “sea level” of the vascular system and therefore the natural reference for hemodynamic measurements. Very good reasons must be presented to justify its replacement. However, the evidence for an infra-diaphragmatic reference is weak and based on studies with unphysiologic or dubious design (10,11). Therefore, the present study was undertaken to systematically investigate the accuracy of HVPG measurement and reevaluate the use of the hepatic atrial pressure gradient (HAPG).

MATERIALS AND METHODS

The present study is a prospective, noninterventional, morphologic and hemodynamic study. Approval for the study was obtained by the ethics committee of our institution, and all patients gave their informed consent to undergo TIPS creation and pressure measurements. Angiograms and pressure measurements in the hepatic vein, IVC, and right atrium were performed as part of the TIPS creation procedure. Inclusion and exclusion criteria for the study were the same as for TIPS creation and followed the recommendation of the Consensus Conference of Baveno IV (12) and the German guidelines for the treatment of ascites (13). The sample size was open because the study intended to show individual variations in the morphology of hepatic veins that could affect pressure measurements.

Twenty-nine consecutive patients with cirrhosis and complications of portal hypertension undergoing TIPS creation were included. The characteristics of the patients are summarized in **Table 1**. Most patients had alcoholic cirrhosis with refractory ascites that constituted Child–Pugh class B disease. Almost 77% of the patients had ascites. The mean Model for End-stage Liver Disease score was 12. In all patients, pressure

Table 1. Baseline Characteristics of Study Patients

Measurement	Value
No. of patients	29
No. of measurements	30
Sex	
Male	19 (65.5)
Female	10 (34.5)
Age (y)	
Mean \pm SD	63.2 \pm 11.1
Range	35–81
Etiology of liver disease	
Alcohol	20 (69.0)
Hepatitis B	3 (10.3)
Hepatitis C	2 (6.9)
Cryptogenic	4 (13.8)
Indication for TIPS	
Ascites	10 (34.8)
Varices	5 (17.2)
Varices and ascites	12 (41.4)
Hepatic hydrothorax	2 (6.9)
Child–Pugh class	
A	7 (24.1)
B	19 (65.6)
C	3 (10.3)
MELD score	
Mean \pm SD	12.4 \pm 4.3
Range	7–23
Laboratory tests	
INR	
Mean \pm SD	1.20 \pm 1.51
Range	0.98–1.5
Hemoglobin (g/dL)	
Mean \pm SD	10.8 \pm 2.0
Range	7.9–14.2
Platelets ($\times 10^9/L$)	
Mean \pm SD	118 \pm 62
Range	52–279
Creatinine (mg/dL)	
Mean \pm SD	1.4 \pm 0.8
Range	0.5–4.0
AST (U/L)	
Mean \pm SD	47 \pm 19
Range	26–83
ALT (U/L)	
Mean \pm SD	29 \pm 17
Range	12–66
Albumin (g/dL)	
Mean \pm SD	3.4 \pm 0.6
Range	2.5–4.5
Bilirubin (mg/dL)	
Mean \pm SD	1.2 \pm 1.0
Range	0.5–4.7

ALT = alanine aminotransferase; AST = aspartate aminotransferase; INR = International Normalized Ratio; MELD = Model for End-stage Liver Disease; SD = standard deviation; TIPS = transjugular intrahepatic portosystemic shunt.

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