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Review Article

Radiology Section

In Pictures: Hepatic Venous Pressure Gradient - Indications, Technique and Complications

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ABSTRACT

Hepatic venous pressure gradient measurement is an important technique in diagnosis, prognosis and management of portal hypertension. The technique and indications have come a long way and currently, many centres perform this test safely and reliably. Even though the literature provides insights into hepatic venous pressure gradient measurement, a pictorial representation of the same seems to be lacking. In this pictorial review, we describe the indications, technique, complications and inadvertent mistakes in hepatic venous pressure gradient measurement.

Keywords: Cirrhosis, Esophageal varices, Portal hypertension

INTRODUCTION

Hallion and Francois-Frank in 1896 utilized mesenteric vein catheterization connected to a water manometer in a dog for measuring portal venous pressure [1]. Myers and Taylor in 1951 performed the first occlusive hepatic vein catheterization for measuring 'Wedged Hepatic Vein Pressure' (WHVP) [2]. The WHVP closely reflects portal pressure but is more related to hepatic sinusoidal pressure. Currently, utilized modality is however, the Hepatic Venous Pressure Gradient (HVPG) which is the difference between WHVP and Free Hepatic Vein Pressure (FHVP). HVPG represents the pressure between portal vein and intra-abdominal vena cava. It is not affected by changes in intra-abdominal pressures, as seen with WHVP and FHVP and eliminates the external zero reference point, which varies from centre to centre [3,4]. The WHVP measurement was modified in 1979 with the use of balloon occlusion catheter. Some operators advice for measurements of HVPG utilizing the WHVP and supra hepatic IVC pressure instead of FHVP [5]. Normal HVPG ranges from 1-5 mmHg. Portal Hypertension (PHTN) is defined when HVPG ≥ 6mmHg. HVPG>10 mmHg is known as clinically significant PHTN (CSPH). In compensated cirrhosis, patients are sub-classified into Stage 1, without varices and Stage 2 (HVPG > 10 mmHg) with varices. Stage 3 and 4 cirrhosis is when HVPG is more than 12 mmHg in the presence of severe decompensation events. Patients with HVPG > 10 mmHg have one year mortality rate that ranges from 30 to 60%. Acute variceal bleeding in a cirrhotic with HVPG ≥ 20 mmHg has very poor outcome and salvage with trans jugular intrahepatic portosystemic shunting leads to better survival in properly selected patients. HVPG also identifies patients with compensated cirrhosis who have good outcomes after curative resection of hepatoma [6-8].

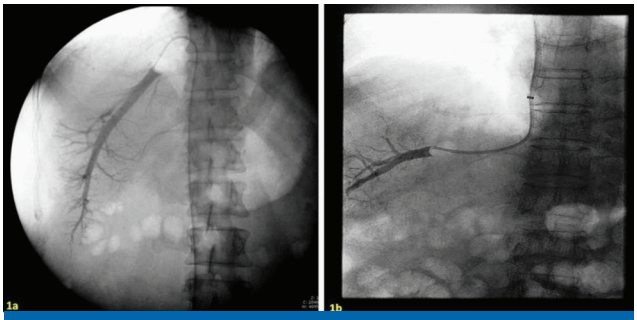
PREPARATION

The indication for performing HVPG measurement must be legible and the patient counselled regarding procedure, technique and its related complications. Contraindications to HVPG include severe cardiac or pulmonary disease, hypersensitivity to contrast agents, pregnancy and active encephalopathy. Patency of hepatic veins pre-procedure using Doppler or contrast (preferably computed tomography) imaging study of the liver is important. Consent must be taken prior to procedure with the patient fasting for at least 6-8 hours and adequately hydrated. Sedation with midazolam 0.1 to 0.2 mg/kg can be given before procedure in case of apprehension. Next, make sure all required instruments are available and in place – 6 Fr balloon catheter (Swan-Ganz/ 7 Fr Goodale-Lubin syringes, sterile gauze pieces, vascular introducer sheath, puncture needle, contrast dye, lignocaine solution, quartz pressure transducer (venous, not arterial) and specialized angiographic sets with guide wires. The tubing between catheter and transducer should be as short as possible and at the same level as the transducer. The tubing should be flushed with heparinised saline and kept free of air bubbles.Venous pressure measurement should be done using an appropriate scale. The upper range of venous pressure is usually between 30 to 40 mmHg. Scales used for arterial pressure measurements are not useful. The venous pressure scale is able to detect small changes and ideally should be

set at 1 mmHg = 1 mm scale. While recording, slow speed should be used. However, an appropriate speed is 5 mm/sec, but an optimal speed would be 1-2 mm/sec. The pressure transducer should be kept at the level of the right atrium in the mid axillary line.

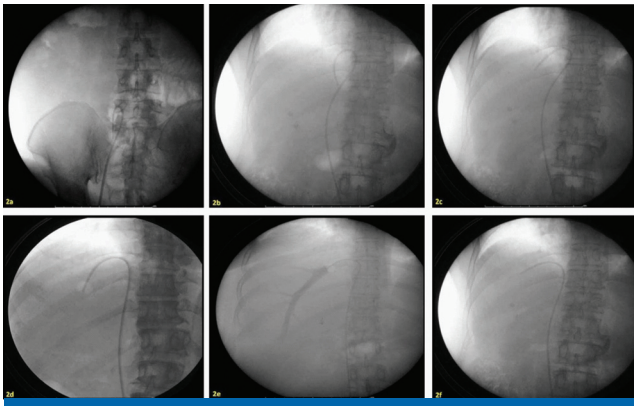
TECHNIQUE

Venous introducer sheath is placed in the access vein (right antecubital, femoral or jugular) under aseptic conditions after local anaesthesia, using Seldinger technique and under Doppler guidance [9] [Table/Fig-1a&b].



[Table/Fig-1a-b]: (a) HVPG measurement through transfemoral; (b) transjugular route.

Under fluoroscopic guidance, 7 Fr balloon catheter is introduced through the vascular access into the right femoral vein and upwards into right external iliac vein and into right common iliac vein. At the juncture of Inferior Vena Cava (IVC) and common iliac vein, the catheter is made to form a loop [Table/Fig-2a] which is necessary. This loop can also form higher up, at the juncture of right renal vein and IVC. The looped catheter is now further advanced up till the Right Atrium (RA) - IVC junction [Table/Fig-2b]. The catheter is then slowly pulled back, so as to introduce and hook the tip into the right hepatic vein (about 3 to 4 cm from its opening into IVC), for HVPG measurement [Table/Fig-2c].



[Table/Fig-2a-f]: (a) Catheter loop formation; (b) after introduction through vascular access with pull back; (c) hooking into the hepatic vein; (d-e) checking for adequate wedging and; (f) measuring for free hepatic venous pressure.

Once the catheter is inside the hepatic vein, further introduction into the vein can be utilized for measuring catheter WHVP or balloon occlusion can be used. The latter is more useful as the catheter can be inflated and deflated in the same position to check WHVP and FHVP [Table/Fig-2d].

The WHVP is confirmed after at least 60 seconds of observation. Adequate occlusion of hepatic vein is checked in the presence of (a) inability to withdraw blood on suctioning catheter; (b) lack of venous wave form on the tracing; (c) classical wedged pattern/sinusoidogram without reflux of contrast or washout through collateral circulation. The wedged pressure must be taken before instillation of dye into the vein. Vice-versa, this could lead to falsely high values because of contrast per say in the vein which is not a good medium for transmitting pressure. Instil the contrast agent slowly (5mL) for check venogram to confirm complete occlusion. An ideally occluded venogram shows typical sinusoidogram without communication with other hepatic veins [Table/Fig-2e].

The balloon is then deflated and FHVP is checked thereafter [Table/Fig-2f].

Deep introduction of catheter into the vein gives false readings of FHVP. Ideally FHVP should not be > 1 to 2 mmHg than the IVC pressure. If the FHVP is more than 2 mmHg than IVC, then the catheter must be withdrawn and measurement of FHVP done close to the IVC for accuracy. FHVP is checked for at least 15 seconds.

The readings must be taken at least 3 times and mean should be documented. If the readings differ by 1 mmHg from each other, then the measurement should be obtained again. The catheter should be rinsed with heparinised saline before each set of readings. After measuring the HVPG, withdraw the catheter (make sure the balloon is deflated) and measure IVC pressure, followed by the right atrial pressure [Table/Fig-2g].

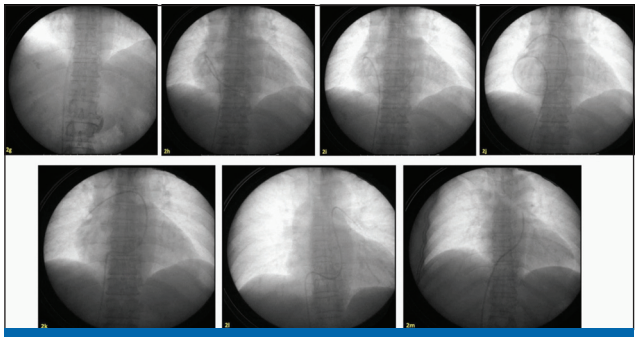
Advancement of the catheter tip further into the right ventricle from the right atrium is done, so as to form a loop, when the catheter strikes the posterior right atrial wall [Table/Fig-2h].

Our aim now was to measure the Pulmonary Capillary Wedge Pressure (PCWP). The loop is further advanced upwards and towards the right all the while maintaining it intact. A properly directed catheter moves towards the pulmonary artery and further into pulmonary capillaries. Ideally, taking the form of a 'mirrored 6' [Table/Fig-2i and j].

Advance the catheter to wedge the tip into the capillaries. Withdraw catheter slowly, towards the operator to release the loop (the catheter forms a '?' eventually) [Table/Fig-2k].

Alternatively, PCWP can also be checked on the left side as shown in [Table/Fig-2l].

After measuring the PCWP, the catheter is withdrawn and positioned near left sternal region at midline, near to the left



[Table/Fig-2g-m]: (g) Measuring the IVC pressure, RA pressure; (h-k) and thereafter looping and advancing the tip to enter pulmonary capillaries; (l,m) to measure PCWP and pulling back to measure PA pressure.

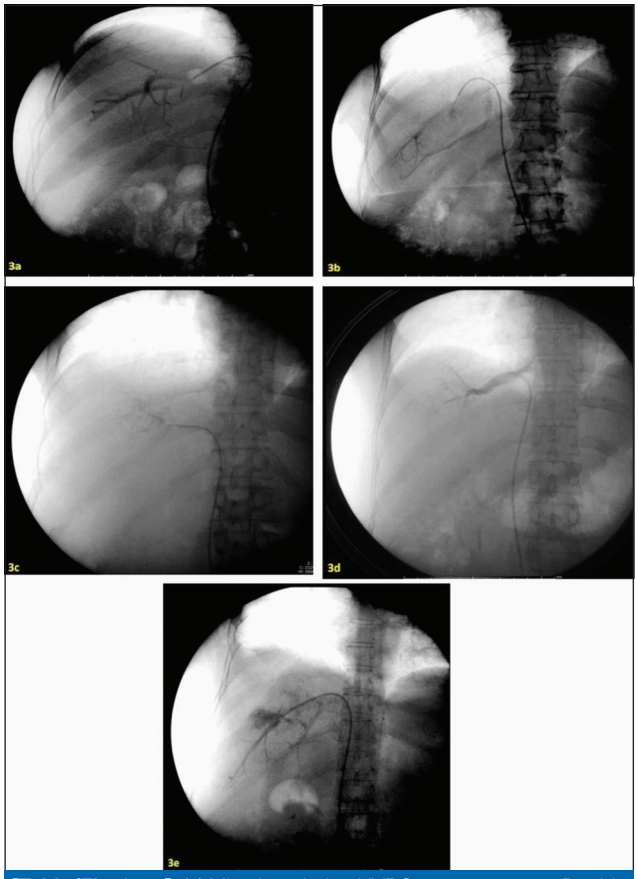
main bronchus. A pulsatile movement of the tip confirms the presence in the Pulmonary Artery (PA). Measure the PA pressure in this position [Table/Fig-2m].

All readings must be documented well. Make sure patient is comfortable, lying still and breathing quietly. Coughing and deep breathing movements lead to false reading on the tracing. Once the procedure is completed, remove the catheter and the vascular sheath access, apply tight bandage pressure for 10 to 15 minutes, confirm hemostasis and closely observe the site and patient hemodynamics. The part should be immobilized for 6 hours and the abdomen and peripheral pulses should be palpated for alarming signs over the next 24 hours.

MISTAKES IN MEASUREMENT OF HVPG

Operator dependent mistakes can occur during measurement of HVPG. There could be inadvertent occlusion of double veins during the procedure when the balloon inflation occurs at the junction between two veins [Table/Fig-3a].

In the presence of veno-venous collaterals [Table/Fig-3b] the HVPG measurement becomes erroneous (falsely low). In this scenario, the occlusion must be done distal to the collateral or, cannulation of another vein must be attempted for adequate measurement of HVPG. Cannulation of small veins [Table/Fig-3c] should be avoided. HVPG values will be falsely high in this scenario and attempts must be done to canulate the right hepatic vein ideally. Inadequate balloon inflation results in leak of contrast back into the IVC [Table/Fig-3d] and abnormal HVPG measurement. Check venogram must be performed to confirm complete occlusion, followed by at least 3 readings. Parenchymal damage [Table/Fig-3e] occurs inadvertently in the event of forceful cannulation with venous injury. HVPG measurement related mortality has never been documented yet. Very few complications related to local injury at cannulation site, leakage, hematoma formation and vagal reactions, rupture of venous introducers and arterio-



[Table/Fig-3a-e]: (a) Mistakes during HVPG measurement - Double vein occlusion; (b) veno-venous collaterals; (c) small vein cannulation; (d) inadequate balloon inflation and; (e) parenchymal damage due to forceful cannulation.

venous fistula formation have been reported. Catheter passage through right atrium, ventricle and pulmonary artery can produce transient self-limiting arrthymias [10].

CONCLUSION

Currently, the most commonly used parameter for assessment of cirrhosis and portal hypertension is the HVPG which represents the gradient between pressures in the portal vein and the intra-abdominal inferior vena cava. Current literature is rich with written details on techniques and complications of HVPG. In this review, a pictorial aspect to real time HVPG measurement has been provided which is intended to make the procedural understanding simple and clear. The step wise intelligible description should help guide students of Radiology and Hepatology alike in performing HVPG with ease and confidence.

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