Hospital-Based Evaluation and Management of Portal Hypertension Syndrome

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Abstract—**Portal hypertension is a major clinical syndrome defined by a sustained elevation of pressure within the portal venous system, most commonly associated with chronic liver disease and cirrhosis. It develops primarily due to increased resistance to portal blood flow at the intrahepatic level, caused by structural changes such as fibrosis, regenerative nodules, and sinusoidal capillarization, along with dynamic factors including endothelial dysfunction and increased hepatic vascular tone. In addition, increased splanchnic blood flow resulting from systemic and splanchnic vasodilation further exacerbates portal pressure[1]. Clinically significant portal hypertension leads to the formation of portosystemic collaterals and serious complications such as esophageal and gastric varices, variceal hemorrhage, ascites, splenomegaly, hypersplenism, hepatic encephalopathy, and hepatorenal syndrome, all of which contribute substantially to morbidity and mortality. Diagnosis is based on clinical assessment, imaging modalities, endoscopic evaluation of varices, and measurement of the hepatic venous pressure gradient, which remains the gold standard for assessing severity[2]. Management strategies focus on preventing and treating complications through pharmacological therapy, endoscopic interventions, radiological procedures such as trans-jugular intrahepatic portosystemic shunt placement, and liver transplantation in advanced disease. Recent advances emphasize non-invasive diagnostic techniques and novel therapeutic targets aimed at reducing intrahepatic resistance and improving patient outcomes[3].**

Index Terms—**Portal hypertension; Hepatic venous pressure gradient (HVPG); Cirrhosis; Intrahepatic vascular resistance; Splanchnic circulation; Portosystemic collaterals; Esophageal varices; Ascites; Hypersplenism; Variceal bleeding; Endothelial dysfunction; Trans-jugular intrahepatic portosystemic shunt (TIPS); Liver transplantation; Non-selective beta-blockers.**

I. INTRODUCTION

Portal hypertension refers to elevated pressure within the portal venous system. Gilbert and Carnot introduced the term "portal hypertension" in 1902 to describe features and complications arising from increased pressure in the liver's venous circulation. The condition involves an increased portal pressure gradient, defined as the difference between portal venous pressure and the pressure within the inferior vena cava or hepatic vein. A normal hepatic venous pressure gradient (HVPG) measures ≤5 mm Hg. A gradient of ≥6 mm Hg suggests portal hypertension, while a range of 5 to 9 mm Hg indicates subclinical disease[4].

Portal hypertension is a common and serious clinical condition defined by an abnormal increase in pressure within the portal venous system, most frequently arising as a consequence of chronic liver disease and cirrhosis. Under normal physiological conditions, portal venous pressure remains low; however, pathological alterations in hepatic architecture and vascular regulation lead to increased resistance to portal blood flow, resulting in sustained elevation of portal pressure[5].

Despite advances in diagnostic and therapeutic approaches, portal hypertension remains a major cause of hospitalization and death in patients with chronic liver disease. Understanding its pathophysiology, clinical manifestations, and management strategies is therefore essential for effective prevention and treatment of its life-threatening complications[6].

II. ETIOLOGY

The etiology of portal hypertension is determined by the anatomical site at which resistance to portal blood flow occurs and is classically classified into

prehepatic, intrahepatic, and posthepatic causes. Prehepatic portal hypertension results from obstruction to portal venous inflow before it enters the liver and includes conditions such as portal vein thrombosis, splenic vein thrombosis, congenital portal vein anomalies, and external compression of the portal vein[7].

Posthepatic portal hypertension occurs due to impaired hepatic venous outflow and is commonly caused by Budd–Chiari syndrome, inferior vena cava obstruction, right-sided heart failure, constrictive pericarditis, and severe tricuspid regurgitation. These diverse etiological factors ultimately lead to increased portal venous pressure by raising vascular resistance and disrupting normal hepatic blood flow, thereby contributing to the development of portal hypertension and its complications[8].

Intrahepatic portal hypertension is the most common category and is further subdivided into presinusoidal, sinusoidal, and postsinusoidal causes. Cirrhosis of the liver represents the predominant sinusoidal cause worldwide and arises from chronic liver diseases such as viral hepatitis, alcoholic liver disease, and non-alcoholic fatty liver disease. Other intrahepatic causes include schistosomiasis, non-cirrhotic portal fibrosis, nodular regenerative hyperplasia, and infiltrative diseases affecting the hepatic parenchyma[9].

III. EPIDEMIOLOGY

Cirrhosis of the liver is the most prevalent cause of portal hypertension in the Western world. However, schistosomiasis is the most frequent cause in Africa, where schistosomiasis is endemic. About 2.4 % of all deaths worldwide were attributed to cirrhosis in the year 2017, approximately 1.32 million deaths[10].

Portal hypertension is a major global health problem, closely associated with chronic liver disease and cirrhosis, which represent the leading causes worldwide. It is estimated that more than 50–60% of patients with cirrhosis develop clinically significant portal hypertension, and its prevalence increases with disease progression. Cirrhosis itself affects over 1.5 billion people globally, making portal hypertension a common and clinically important complication[11].

The burden is particularly high in regions with a high prevalence of chronic viral hepatitis (such as Asia and Africa), alcohol-related liver disease (Europe and North America), and the rapidly increasing incidence of non-alcoholic fatty liver disease worldwide. Esophageal varices, a direct consequence of portal hypertension, are present in approximately 30–40% of patients with compensated cirrhosis and up to 60–85% of those with decompensated cirrhosis, with an annual risk of first variceal bleeding of 5–15%[12].

IV. PATHOPHYSIOLOGY

The liver receives its blood supply from the hepatic artery and the portal vein, most of which is from the portal vein. The superior mesenteric and splenic veins join to form the portal vein, which is 7 to 8 cm long. The portal vein carries blood from the spleen, pancreas, and gallbladder, as well as from the esophagus, stomach, and large and small intestines. It drains into the liver before dividing into the right and left portal veins and goes to the respective parts of the liver. The blood from the portal vein enters the liver sinusoids and drains into the hepatic veins before entering the inferior vena cava and finally into the systemic circulation[13].

The portal vein pressure is typically between 1 and 4 mm of mercury, more than the hepatic vein pressure. This pressure differential enables blood to flow through the liver into the systemic circulation. The veins do not have valves. Resistance to blood flow in the portal venous tract leads to elevated portal venous pressure, as seen in portal hypertension. The resistance occurs more commonly within the liver, as seen in cirrhosis, but it can also be prehepatic or posthepatic[14].

Collateral circulation and sustained portal hypertension contribute to decreased systemic blood pressure and reduced effective arterial blood volume. This reduction triggers activation of the renin-angiotensin-aldosterone system, resulting in sodium and water retention[15].

Historically, cirrhosis was viewed solely as a pro-hemorrhagic condition. Current understanding recognizes a complex balance, with both pro-hemorrhagic and prothrombotic tendencies. The prothrombotic state may accelerate hepatic fibrosis and contribute to pulmonary hypertension. In cirrhosis, bacterial translocation from the gut lumen to the systemic circulation occurs frequently, likely due to increased portal pressure. Bacterial products stimulate hepatic stellate cells and Kupffer cells, promoting fibrogenesis and angiogenesis, thereby exacerbating portal hypertension[16].

V. EVALUATION

Imaging Studies

Ultrasound and computed tomography (CT) scan of the abdomen can identify signs of portal hypertension, which include splenomegaly and portosystemic collaterals, cirrhotic changes in the liver, and ascites[17]. Magnetic resonance imaging (MRI), enhanced with Gadolinium, can detect esophageal varices. Doppler ultrasound of the portal vein can detect the presence of stenosis or thrombosis. The Doppler ultrasound study of the portal vein will show either hepatopetal portal vein flow (toward the liver) or hepatofugal portal vein flow (away from the liver), depending on the degree of portal hypertension. Hepatopetal flow is normal[18].

All patients with cirrhosis require evaluation for CSPH. Management with a non-selective beta blocker (NSBB) should be considered in appropriate cases. When NSBB use is not feasible, endoscopic screening for varices becomes necessary[19]. In the absence of varices, repeat screening is recommended every 2 to 3 years, depending on the patient's clinical condition and risk factors. If varices are identified and found to be large, prophylactic therapy should be initiated. Additionally, patients with ascites require diagnostic paracentesis to determine the underlying cause and exclude spontaneous bacterial peritonitis[20].

In cases where clinical features of portal hypertension are evident, direct portal pressure measurement is generally unnecessary. Evaluation of portal and hepatic vein patency can be performed using duplex Doppler ultrasound, magnetic resonance imaging, or computed tomography angiography. Direct measurement, though accurate, involves invasive hepatic vein catheterization to determine free hepatic vein pressure (FHVP) and wedged hepatic vein pressure (WHVP). The hepatic venous pressure gradient (HVPG), calculated by subtracting FHVP from WHVP (HVPG = WHVP - FHVP), serves as the gold standard for diagnosing portal hypertension but remains limited to specialized centers due to its complexity and cost[21].

VI. TREATMENT

Patients can be treated medically with NSBB, which prevents variceal bleeding. These drugs reduce cardiac output, thereby decreasing splanchnic blood flow and increasing resistance in the splanchnic vascular system, ultimately leading to reduced portal blood flow. The result is a reduction in the HVPG. Carvedilol also promotes nitrous oxide release and subsequently causes a further decrease in portal pressure and is more effective in reducing HVPG than propranolol and nadolol[22]. The suggested starting dosage is 6.25 mg daily, increasing to 12.5 mg daily (in divided doses) if tolerated well after 2 to 3 days. Reducing the dosage should be considered if the systolic blood pressure drops below 90 mm Hg. The most recent AASLD practice guidelines recommend carvedilol as the preferred NSBB[23].

Approximately 40% of patients with cirrhosis and 60% of those with both cirrhosis and ascites develop esophageal varices. Abstinence from alcohol often leads to improved liver function and, in some cases, regression of varices[24]. Variceal bleeding occurs in about 25% of newly diagnosed varices within 2 years. Nearly half of initial variceal bleeding episodes stop spontaneously due to hypovolemia-induced splanchnic vasoconstriction, which lowers portal venous pressure. Rebleeding occurs in approximately 40% of cases within 5 days of the initial hemorrhage[25].

In cases of variceal bleeding, immediate resuscitation with intravenous fluids and placement of 2 large-bore intravenous (IV) lines is essential, followed by admission to an intensive care unit. Transfusion should be initiated when hemoglobin levels fall below 7 g/dL[26]. Medications that reduce splanchnic blood flow vasopressin, terlipressin, somatostatin, or octreotide should be considered. Octreotide is typically given as a 50 µg IV bolus followed by a continuous infusion of 50 µg/hour for 3 to 5 days. Somatostatin is administered as a 250 µg bolus followed by an infusion at 250 µg/hour over the same period. Terlipressin is administered as a 2 mg IV bolus, followed by 1 to 2 mg every 4 to 6 hours until hemostasis is achieved, or for up to 5 days[27].

Prophylactic antibiotics help prevent spontaneous bacterial peritonitis[28]. Ceftriaxone 1 g IV daily is recommended for 7 days, with a potential switch to oral ciprofloxacin 400 mg twice daily or levofloxacin 500 mg daily. Endoscopy should be performed within 12 hours of admission. Endoscopic variceal ligation is indicated for large varices or varices with high-risk stigmata. For ongoing bleeding despite ligation and pharmacologic therapy, placement of a transjugular intrahepatic portosystemic shunt (TIPS) should be considered. TIPS establishes a connection between the

intrahepatic branches of the portal and hepatic veins, effectively lowering portal pressure. However, diverting portal blood flow reduces hepatic perfusion, increasing the risk of hepatic encephalopathy[29].

VII. DIFFERENTIAL DIAGNOSIS

Differential diagnoses that should also be considered in the evaluation of portal hypertension include[30]:

- Budd-Chiari syndrome
- Cirrhosis
- Constrictive pericarditis
- Myeloproliferative disease
- Polycystic kidney disease
- Sarcoidosis
- Tricuspid regurgitation
- Tuberculosis
- Vitamin A deficiency

VIII. PROGNOSIS

The prognosis of portal hypertension largely depends on the underlying etiology, severity of liver disease, and the presence of complications. Patients with CSPH, particularly those with an HVPG ≥10 mm Hg, face a higher risk of decompensation, including ascites, hepatic encephalopathy, and variceal bleeding. Once HVPG reaches ≥12 mm Hg, the likelihood of life-threatening bleeding and other complications increases significantly.

Early identification and management, including NSBB, endoscopic interventions, and treatment of the underlying cause (eg, antivirals for hepatitis C or anticoagulation for thrombosis), can improve outcomes. Abstinence from alcohol may reverse some complications, while persistent or severe disease may require TIPS or liver transplantation, the only definitive cure for cirrhosis-related portal hypertension. Delayed diagnosis or inadequate management leads to increased hospitalization, higher mortality, and a greater need for transplant evaluation.

IX. COMPLICATIONS

Complications of portal hypertension include:

- Thrombocytopenia due to hypersplenism
- Abdominal wall collaterals
- Variceal bleeding secondary to hemorrhage from gastroesophageal, anorectal, retroperitoneal, stomal, and other varices
- Acute bleeding or iron deficiency anemia due to chronic blood loss from portal hypertensive gastropathy, enteropathy, or coagulopathy
- Ascites
- Spontaneous bacterial peritonitis
- Hepatic hydrothorax

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