THE EFFECT OF SOLID AND LIQUID MEAL ON POST PRANDIAL PORTAL VEIN FLOW VELOCITY IN HEALTHY VOLUNTEERS AND CIRRHOSIS PATIENT WITH PORTAL HYPERTENSION

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This dissertation entitled "**THE EFFECT OF SOLID AND LIQUID MEAL ON POST-PRANDIAL PORTAL VEIN FLOW VELOCITY IN HEALTHY VOLUNTEERS AND CIRRHOTIC PATIENTS WITH PORTAL HYPERTENSION"** " is submitted to the Tamil Nadu Dr. M.G.R Medical University, Chennai, in partial fulfillment of regulations for the award of M.D. Degree in Physiology in the examination to be held during March 2012.

This dissertation is a record of fresh work done by the candidate **Dr. A. MOORTHI,** during the course of the study (2006-2009). This work was carried out by the candidate himself under my supervision.

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CONTENTS

ABSTRACT

AIM

To prove the liquid meal having less influence on Portal vein flow velocity than solid meal in healthy volunteers and cirrhotic patients using colour doppler ultra sonagraphy.

METHOD

32 healthy volunteers and 20 cirrhotic patients were studied after solid and liquid meal ingestion by using color doppler ultra sound missing.

RESULTS

By using ANOVA student 't' test all the results were analysis. The study showed significant decrese in portal flow velocity compare with solid meal in healthy volunteers. In cirrhotic patients there is no significant change between both solid and liquid meal.

CONCLUSION

The study conclude that liquid meal having less influence on portal flow velocity in healthy volunteers. There was no significant change in cirrhotic patients.

INTRODUCTION

The post prandial drowsiness is a common and important physiological phenomenon felt after the meal ingestion in the post prandial period. This is due to diversion of blood from the systemic circulation from inactive tissues like skin, muscles and brain, to splanchnic circulation.

The hemodynamic measurement study on human[1] showed that while splanchnic blood flow is markedly increased, blood flow is significantly reduced in upper and lower limbs as well as the extra splanchnic viscera including brain[1].

The effect of food on splanchnic & systemic hemodynamics was also documented in various animal & human models, which showed that there is an increment of the mesenteric blood flow post prandially to facilitate digestion and absorption of ingested nutrients[2-5].

Recently published studies on animal model proved that increased gut blood flow post prandially is due to shunting of blood from the systemic circulation into splanchnic circulation is mediated by distended stomach and increase the systemic vascular resistance[3]and mean arterial blood pressure .

These physiological stimuli like food intake also affect the deregulated splanchnic circulation in cases of cirrhosis with portal hypertension and lead to a dangerous complication of ruptured esophageal variceal bleeding. The

postprandial increment of portal blood flow is detrimental for rupture esophageal varicies due to sudden increase in portal venous pressure.

An Malaysian study by Lau sieng chuo showed that there is a significant change in portal hemodynamics after the liquid meal post prandially with no significant difference in gender[6].

Rupture esophageal varices is the leading cause of death, secondary to increased portal pressure due to cirrhosis of liver[7]. The postprandial rise in portal blood flow is inversely related to the severity of the portal hyper tension and liver cirrhosis may be a valuable parameter with respect to the variceal bleeding[8].

Portal hypertension is a almost unavoidable complication of cirrhosis and unfortunately portal hypertension caused by cirrhosis generally persist and progressive despite development of even an extensive collateral circulation, this includes gastro esophageal varices which are responsible for the main complication of portal hypertension[9].

In patients with cirrhosis the incidence of esophageal varices ranges from 35% to 80% and approximately 3rd of patients with esophageal varices experience variceal bleeding and upto 70% on the survivors have one or more additional episode of bleeding[7].

The prevalence of varices at the time of diagnosis of cirrhosis is widely variable and ranges from 0% to 80% in 93 progressive studies published from 1980 to 2003[10].

The recent prospective cohort studies showed that the incident of esophageal varices in patients with newly diagnosed cirrhosis is nearly 5% per year[10].

Esophageal varices are present in approximately 40% of patients with cirrhosis and upto 25% patients with newly diagonised varices will bleed at 2 years[9].

The patients who stopped bleeding approximately 1/3rd will re-bleed with next 6 weeks. Off all re-bleeding episodes approximately 40% will take place within 5days of the initial bleed[10].

The risk of death with acute varices bleeding is 5 to 8% at 1st week and 20 to 30% at 6 weeks[10].

The predictors of re-bleeding Hepatic Venus Pressure Gradiant (HVPG)greater than 20mm Hg, and even more important risk of bleeding is virtually absent when HVPG is below 12mm Hg[10].

The rapid and large changes in the portal hemodynamics within a short period of time and portal blood flow velocity can be easily detected by color

Doppler sonography by a well trained sonologists, though this technique seems to have low precision in monitoring chronic changes in portal hemodynamics[11].

Doppler ultrasonagraphy of portal blood flow and portal blood flow volume are useful to define the changes in portal hemodynamic in patients with chronic liver diseases and also ultrasonic Doppler instrument allow a measurement of instantaneous blood flow velocity[12].

Doppler sonography is most affordable method to measure non-invasively the main characteristics of mesenteric and portal blood flow. Despite some well known draw backs such as operator dependence, many studies have documented a tolerable intraobserver and interobserver variability[13].

The studies proved that meal test with post meal PFV measurement are generally accepted as a reproducible noninvasive test to evaluate the severity of portal hypertension[13].

The cross sectional studies have shown that oesophageal varices do not develop flow threshold HVPG of 10mm Hg. A baseline HVPG > 10mm Hg is independently associated with an increased risk of developing varices[7].

The progression of portal hypertension results from

- Prominent obstructive resistance in the liver due to extensive scars, regenerative nodules and vascular remodeling.

- Continuous increase in portal blood flow

Indeed most available therapy for portal hypertension focus on correction of hemodynamic alteration in the portal circulation and the effective therapy for the hired mechanical component of portal Hypertension is usually lacking[10].

Infact therapies targeted towards the increased portal blood flow usually do not normalize portal pressure entirely and often blunt the prominent increase in portal inflow that occurs in response to a meal[10].

The present study tried to demonstrate any alteration in portal blood flow velocity by changing the physical nature of meal without any change in the chemical quality of meal[10].

The meal study was conducted in both normal healthy volunteers and patients with portal hypertension to determine changes in portal blood flow in each different group.

AIMS AND OBJECTIVES

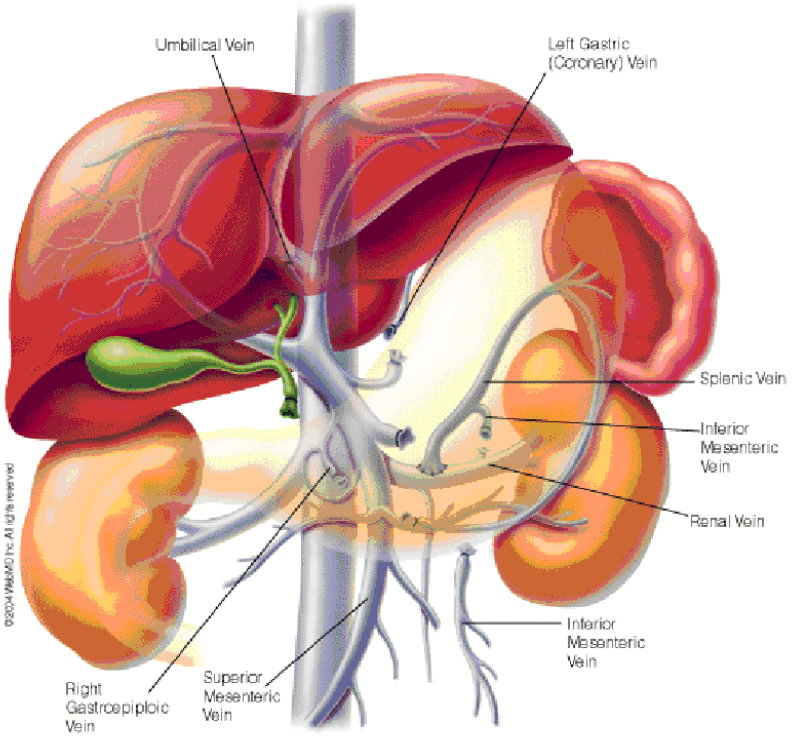
- **To study the effect of solid and liquid meal on postprandial portal vein flow velocity in healthy volunteers and cirrhotic patients with portal hypertension**

- To compare the effect of solid and liquid meal on portal flow velocity in healthy volunteers
- To compare the effect of solid and liquid meal on portal flow velocity in cirrhotic patients
- To study the effect of different meal in different time intervals
- To evaluate the portal blood flow for healthy volunteers and cirrhotic patients with portal hypertension.

REVIEW OF LITERATURE

Physiological Anatomy of Portal circulation:

The Portal vein is formed by the confluence of the splenic vein and superior mesenteric vein behind the neck of the pancreas[14]. The inferior mesenteric vein usually drain into the scenic vein , the left gastric also called left coronary vein drains into portal vein at the confluence of scenic vein and superior mesenteric vein. The portal vein is approximately 7.5 cms in length and run dorsal to hepatic artery and common bile duct into the hilum of the liver[15].



In the hilum of the liver, the portal vein divides into left and right portal vein branches to supply the left and right sides of the liver respectively. The umbilical vein drains into the left portal vein. The cystic vein from gall bladder drains into the right portal vein , where as the portal venules drain into hepatic sinusoids that are drained by hepatic vein into the inferior vena cava. The left and middle hepatic vein join together to drain into the inferior vena cava separately. The right hepatic vein confluence with the inferior vena cava adjacent to the middle hepatic vein. The caudate lobe drains separately into the inferior vena cava[10].

Splanchnic circulation:

The blood vessels of the gastrointestinal system are part of a more extensive system called the splanchnic circulation.it includes the blood flow through the gut itself plus bloods flows through the spleen, pancreas and liver. The design of the system is such that all the blood that courses through the gut, spleen and the pancreas then flows immediately into the liver by the way of portal vein. In the liver the blood passes through millions of minute liver sinusoids and finally leaves the liver by way of hepatic veins that empty into the vena cava of the general circulation[16].

Hemodynamics of the portal blood flow:

The viscera and the liver receive about the 30% of the cardiac out put via the celiac, superior mesenteric and inferior mesenteric arteries. The liver receives about 1000 ml per minute from the portal vein and 500ml/min from the hepatic artery[17].

The portal vein pressure is normally about 10mm Hg in humans and hepatic venous pressure is approximately 5mm Hg. The mean pressure in the hepatic artery branches that converge on the sinusoids is about 90mm Hg, but the pressure in the sinusoids is lower than the portal venous pressure. This pressure drop is adjusted so that there is an inverse relationship between hepatic arterial and portal venous blood flow.

The circulatory system of the normal liver is high compliance, low resistance system that is able to accommodate the large volume of blood as occurs after the meal without increasing the portal pressure[17].

Effect of meal on portal blood flow:

Feeding introduces two types of stimuli, the first immediate stimulus is the mechanical distension of the stomach followed by the distension of the various part of the intestine and the second stimulus is the chemical influence of the digested food. The increase in arterial blood pressure is thought to be primarily mediated via

an increase in the systemic vascular resistance, since the pressure response occurs without any obvious changes in heart rate and contractility. Afferent impulses in the reflex mediating the increase in vascular resistance are initiated by stretch activator mechanoreceptors in the stomach wall and travel via the vagus nerve to the central nervous system. The efferent path way is a sympathetic output via the splanchnic nerve possibly in combination with activation of rennin angiotensin system. This seems to be a complex and precise regulation of postprandial blood flow pattern in vertebrate involving both mechanical as well as chemical stimuli. In mammals chemical stimuli searches by glucose and fat from digested food induced vasodilator responses and are the main determinants of the postprandial hyperemia[3].

Following a meal, food arrives in the stomach mixes with the gastric juices to become chime, and slowly emptied into the small intestine. This rate of emptying is largely governed by the stomach and is dependent on the chemical and physical properties of food. The chime is digested as it travels through the small intestine and this propagating metabolic front is met by an increase in blood flow through the capillaries supplying the gut wall, which can be seen at a macroscopic level as an increase in flow through the superior mesenteric artery[3].

Gastric emptying rates show substantial inter- and intra subject variability and are dependent on meal nutrient content and physical properties. Emptying of digestible solids is generally characterized by a lag phase followed by a period

during which emptying rate is approximately constant. In contrast, isotonic liquid meals need no trituration and hence exhibit a different pattern of gastric emptying, more quickly and following an exponential relationship. Nutrient containing liquids lie between these two extremes with the rate of emptying rising quickly to 1.5 to 3 K cal / min. the presence of solid and liquid food in the same meal leads to modification of the emptying profile of both food[18].

Recently published study on effect of mechanical stomach distension on the gastrointestinal blood flow in rainbow trout. Shows that when the stomach was mechanically distended using an inflatable nitric balloon, the dorsal aortic pressure increased by up to 29% within min, after filling the balloon with a volume corresponding to the natural meal. This increase was mediated via an increase in the systemic circulation through the activation of adrenoceptor. No gastrointestinal hyperemia was seen and they speculate that additional stimuli are needed to evoke to increase gut blood flow and that increased systemic resistance prepares for the shunting of blood to the gut.

The fact that this shows that lag phase cannot account for the rapid increase in gut blood flow after 30 mins. This rapid response could indicate presence of gastric chemoreceptors that sense existence of food in the stomach[2].

In 1970 Chou *et al.* has performed on characterizing the response of the gut to the various luminal content. In descending order, the most potent induces of

increased blood flow to the gut or; lipids and fats, glucose and other carbohydrate, proteins, peptides and amino acids. Chou also experimented with the solid and fluid phases of the chime and they found that compounds responsible for postprandial hyperemia exist in the hydrolytic products of food digestion.

Cholecystokinin has been implicated in postprandial intestinal hyperemia because systemic administration of the peptide produces intestinal vasodilatation .CCK may act either directly on the central nervous system of influence sympathetic vasomotor function and/or peripherally via vagal afferent fibers, conveying inhibitory sensory signals to the brain and subsequently to pre-sympathetic vasomotor neurons[4].

The activation of neuronal discharge by CCK ranged from 50% to 400% increase above resting discharge[4].

CCK also acts on gastrointestinal blood flow. Digestion is accompanied by intestinal vasodilatation (postprandial hyperemia, which is dependent on an intact vagus but not mediated by parasympathetic vasodilator activity[4].

A potential mechanism that may play a permissive role in postprandial hyperemia is withdrawal of sympathetic vasomotor drive to the gastrointestinal vasculature; CCK is a potential mediator of such a mechanism since it is released on consumption of a meal in response to the presence of certain nutrients[4].

With an experimental animal model study by **Henric Seth** hypothesized that the initial increase in arterial blood pressure following stomach distension after food might be important to facilitate the subsequent increased in blood flow[3].

A study of chemical nature of food in gastric emptying and superior mesenteric artery blood flow by M B Sidery *et al* conformed that meals with high fat content slows gastric emptying compared with the meal with high carbohydrate content in healthy volunteers and agreed that there was no significant difference between maximal hyperemia after the two meals[19].

A non-invasive Doppler study in normal humans conducted by Dauzat M et-al showed that postprandial hemodynamic changes (increased portal vein blood flow) were maximal 30 mins after a standard balanced liquid meal.

An investigational studies using duplex ultrasound by C Sieber et-al summaries as follow[20]

- Superior mesenteric artery blood flow (SMABF) increase significantly after liquid and solid meals.
- Modified sham feeding did not affect SMABF.
- Intestinal perfusion of the liquid test meal induced an increase in SMABF of similar magnitude to that observed with oral intake.

- SMABF increased significantly after iso caloric and iso-asmatic loads of intra duodenal carbohydrates, fat and protein meals[20].

The findings of the study by PJ Collins *et al* revealed gastric emptying for solid meal was slower than liquid emptying and was characterized by a delay (lag period) which is followed by linear emptying. Liquid emptying usually followed a single exponential pattern[18].

The study conducted by s' Obrien *et al* suggested that that the postprandial increase in portal venous pressure in patients with cirrhosis is mediated by an increase in hepatic blood flow and modified by a simultaneous decrease in Post sinusoidal resistance[21].

It is well known that portal pressure increases during the postprandial period. It is caused by an augmentation of blood flow into the splanchnic area, a phenomenon known as "postprandial hyperemia.

Haemodynamic measurement show that, while splanchnic blood flow is markedly increase, blood flow is significantly reduced in upper and lower limbs as well as extra – splanchnic viscera including the brain[1].

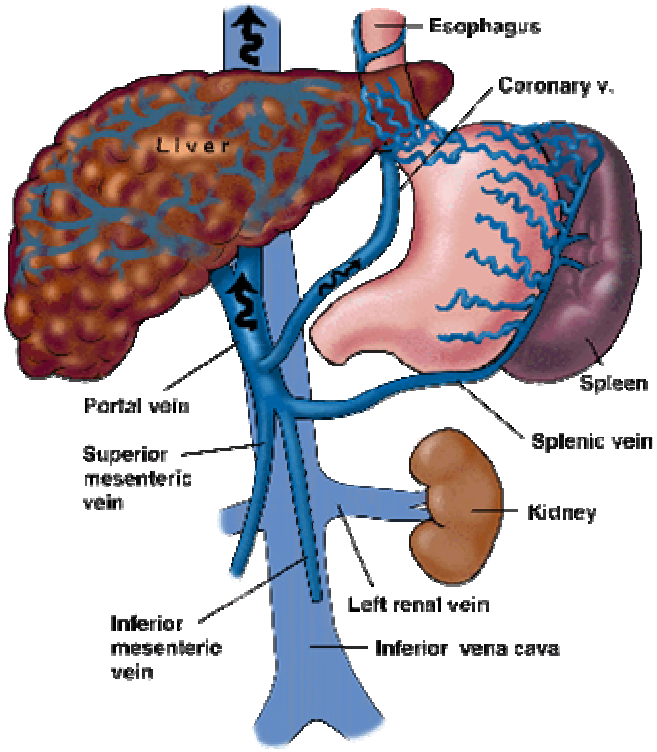
The findings of the study by color Doppler method conducted by Lau Sieng Chuo et-al demonstrate that a measurable increase in portal vein velocity after standard meal ingestion in normal adult and there is no significant difference in other parameters of vessels where found between ethnic, age and general group[6].

Results of a study in rat models by Israel Ramirez revealed that feeding a liquid diet increase energy intake, weight gain and body fat in rats[22].

Portal hypertension:

Portal hypertension is a common clinical syndrome associated with chronic liver diseases and characterized by a pathological increase in portal pressure. Increase in portal pressure is because of increase in vascular resistance and an elevated portal blood flow .the site of increased intra hepatic resistance is variable and is dependent on the disease process. The site of obstruction may be prehepatic , hepatic and post hepatic. In addition, part of increase intra hepatic resistance is because of increased vascular tone. Another important factor contributing to increase portal pressure is elevated blood flow[23].

1. Portal Hypertension



Pathophysiology of portal hypertension

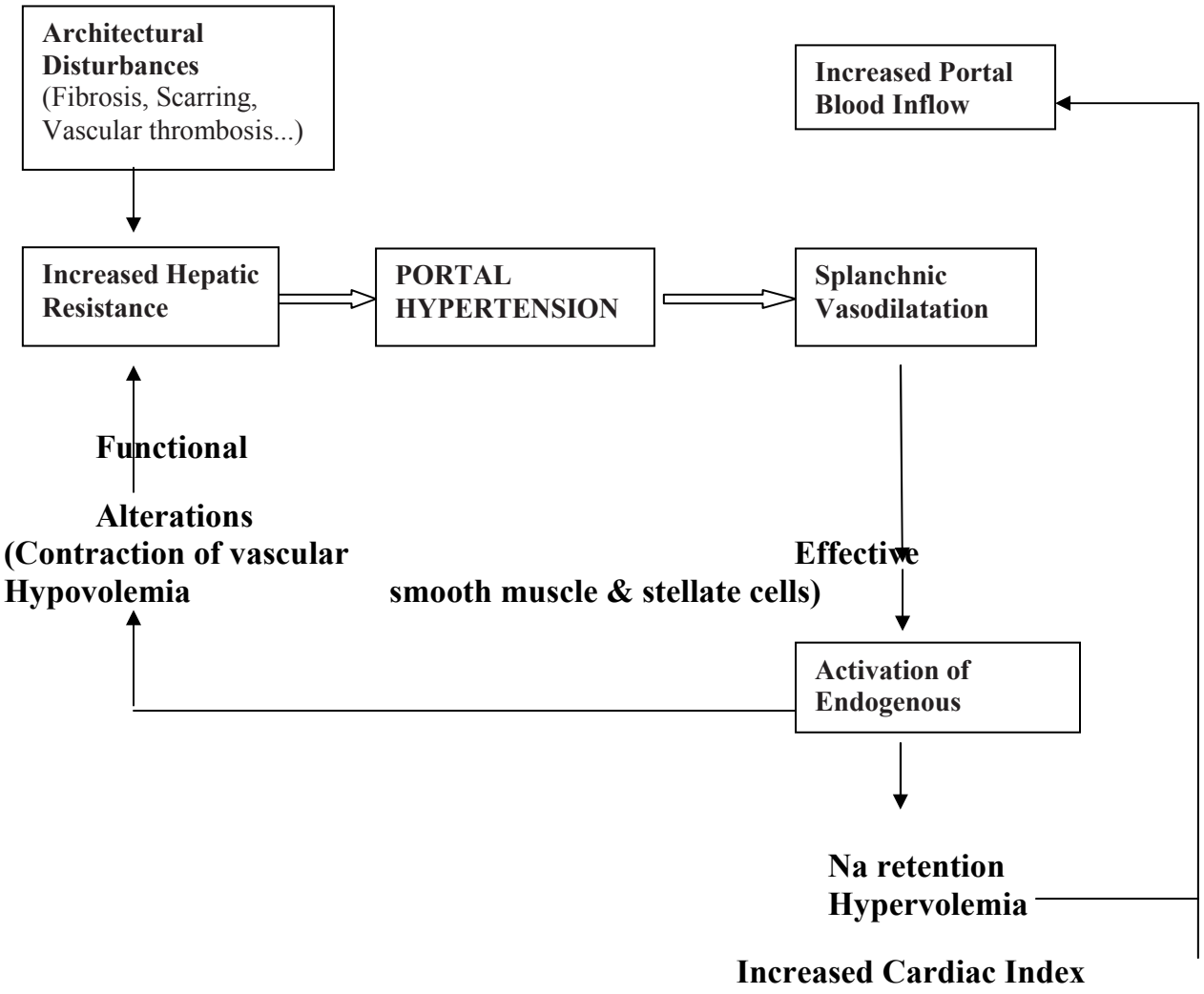
When the portal pressure gradient (the difference between pressures in the portal and the inferior vena cava veins: normal value below 6 mmHg) increases above 10-12 mmHg, complications of portal hypertension can occur.These complications represent the first cause of death and the main indication for liver transplantation in patients with cirrhosis[24].

The portal pressure gradient is determined by the product of portal blood flow and the vascular resistance that opposes that flow. Ohm's law defines this relationship in the equation:

$$\Delta P = Q \times R$$

in which ΔP is the portal pressure gradient, Q is the flow within the portal venous system, and R is the vascular resistance of the portal venous system, which represents the sum of the resistance of the portal vein, the hepatic vascular bed, and of the portosystemic collaterals. It follows that portal pressure may be increased by an increase in portal blood flow, an increase in vascular resistance, or a combination of both.1,2 However, it is well established that in cirrhosis, the primary factor leading to portal hypertension is an increased resistance to portal blood flow. Later on, an increase in portal venous inflow will help to maintain and aggravate portal hypertension[24].

CIRRHOTIC LIVER[24]



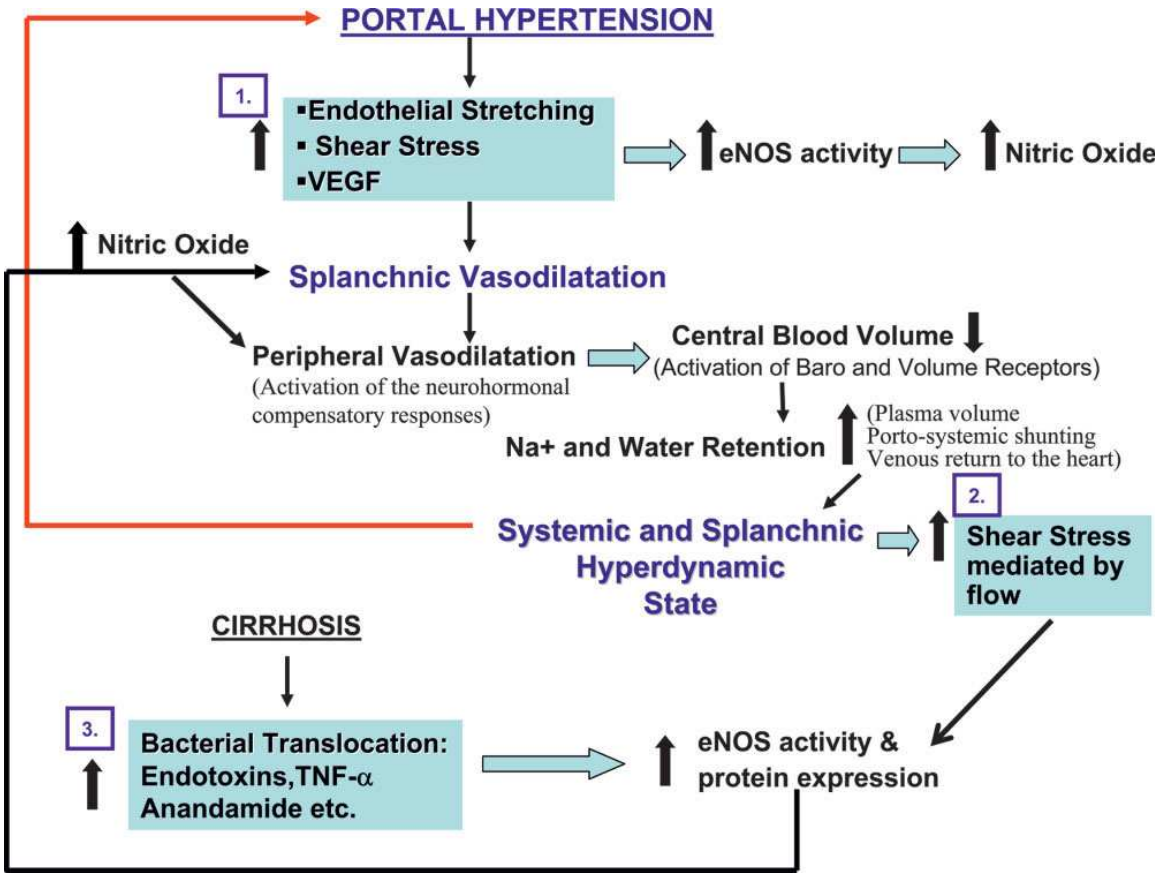
Pathophysiological mechanisms of portal hypertension.

The Hyperdynamic Splanchnic Circulation.

The hyperdynamic splanchnic circulation is central to the development of the syndrome, and although is commonly recognized as a complication of cirrhosis, it should be better conceptualized as a complication of portal hypertension. It has been observed in all forms of portal hypertension caused by a condition other than cirrhosis and confirmed in different experimental models of portal hypertension (Table 1); therefore, it cannot be considered solely a complication of cirrhosis.For many years the dominant theory explaining portal hypertension in cirrhosis was the “backward flow” theory,which postulated that increased portal vascular resistance was the only cause for the increase in portal pressure[25].

Table 1. Experimental Models of Portal Hypertension and Hyper dynamic Circulation[24]*

Rat	Portal Vein Constriction	Groszmann *et al*. Am J Physiol 1982; 242:G156–G160
	Cirrhosis	
	CCl4	Vorobioff *et al*. Gastroenterology 1984; 87:1120–1126
	Thioacetamide	Hori *et al*. Dig Dis Sci 1993; 38:2195–2202
	Bile duct ligation	Lee *et al*. Am J Physiol 1986; 251:G176–G180
Mouse	Portal vein constriction	Iwakiri *et al*. Am J Physiol GI Liver Physiol 2002; 283:G1074–G1081
	Chronic schistosomiasis	Sarin *et al*. Am J Physiol 1990; 258: G365–G369
Rabbit	Portal vein constriction	Cahill P.A. *et al*. Hepatology. 1995; 22(2):598–606
Dog	Bile duct ligation	Levy M. Am J Physiol. 1977; 233:F572–F585 Bosch *et al*. HEPATOLOGY 1983; 3:1002–1007



This theory predicted a splanchnic *hypodynamic* circulation with increased mesenteric vascular resistance. Observations of a decreased portal blood flow at the hepatic hilum supported this theory. This hypodynamic or a normodynamic situation is observed in early cirrhosis when portal hypertension is mainly attributable to an increase in intrahepatic vascular resistance and portal-systemic collaterals have not yet developed. In moderate to severe portal hypertension, however, when an extensive collateral circulation is present, the observation of a decreased portal blood flow entering the liver is misleading because does not take into account portal flow diverted through the collateral circulation. In the late 1960s and early 1970s, a series of studies in patients with well-established

cirrhosis suggested that the splanchnic circulation was hyperdynamic. However, in the early 1980s, when a methodology to evaluate regional hemodynamics and portal-systemic shunting in rodent models of portal hypertension was developed, the hemodynamic events that follow the induction of portal hypertension were unequivocally demonstrated. Increases in splanchnic blood flow together with an increase in portal vascular resistance were shown to contribute to portal hypertension. [25]

This process is called the "forward flow" theory, and it provides a rationale for the use of vasoconstrictors in patients with portal hypertension.

Portal venous pressure is the result of the inter play between portal venous blood flow and the vascular resistance offered to that flow. Whether portal hypertension is maintained only by an increased portal venous resistance are also by increased blood flow within the portal venous system is still open speculation. The hyper dynamic data in cirrhotic rats provide evidence that supports the role of an increased blood flow in portal hypertension and gives quantitative definition of splanchnic Haemodynamic in intra hepatic portal hypertension.

At that time, we coined the name "portal venous inflow" for the splanchnic blood flow entering into the portal system to distinguish it from the portal blood flow perfusing the liver. Portal hypertension is the only known pathophysiological

situation in which the portal blood flow entering into the portal system is different from portal blood flow perfusing the liver[25].

Two dissimilar hemodynamic hypotheses, the "backward flow" theory and the "forward flow" theory have been advanced to define the splanchnic hemodynamics in portal hypertension, indicating that the hyper dynamic portal venous inflow, not resistance provided the main impetus for maintaining the elevated portal venous pressure. The splanchnic hemodynamic observation directly support the forward flow theory of portal hypertension[26]

Vorobioff J.E conducted a study on portal hypertensive rat model proved that the splanchnic hyper dynamic circulation directly support the "forward flow" theory of portal hypertension[27]

The recent study in rat model by Groszmann RJ found that the hyper dynamic splanchnic circulatory state is accompanied by hyper dynamic systemic circulation characterized by high cardiac index and low systemic vascular resistance[28].

An experimental study in cirrhotic rats by Vorobioff J *et al* demonstrated that portal hypertension is maintained least in part by a hyper dynamic portal venous flow and the hemodynamic data in cirrhotic rats provide evidence that supports the role of portal increased blood flow in portal hypertension and gives

quantitative definition of splanchnic hemodynamics in intra hepatic portal hypertension[27].

Yin XY *et al* studied portal hemodynamics and their relationship with esophageal variceal bleeding (EVB) by using color Doppler velocity profile (CDVP) in 69 cirrhotic patient with portal hypertension and 46 healthy volunteers. The study suggested increased flow in the splenic vein may be the primary source of increased portal flow and may play a role in the development of EVB[29].

Hepatic fibrosis causes a marked impairment of portal blood flow into the liver and mal adaptive splanchnic vasodilatation attempts to rectify the associated reduction in hepatic perfusion by increase in blood flow and pressure in the portal venous system. However rather than increasing perfusion of the liver , this hyperemia and hypertension results in incremental shunting of portal blood into the systemic circulation via Porto systemic collateral anastomoses. Progressive collateral shunting exacerbates the reduction in portal blood flow to the liver[1].

Huang J *et al* conducted a study to investigate portal hemodynamics and its correlation with Esophageal variceal bleeding (EVB) in cirrhotic with portal hypertension by using newly developed technique color Doppler velocity profile revealed EVB score may become a valuable parameter in predicting occurrence of EVB and further they conclude that cirrhotic with portal hypertension, portal

venous system has the futures of elevated vascular resistance and hyper dynamic, and later mainly results from increased blood flow in splenic vein[30].

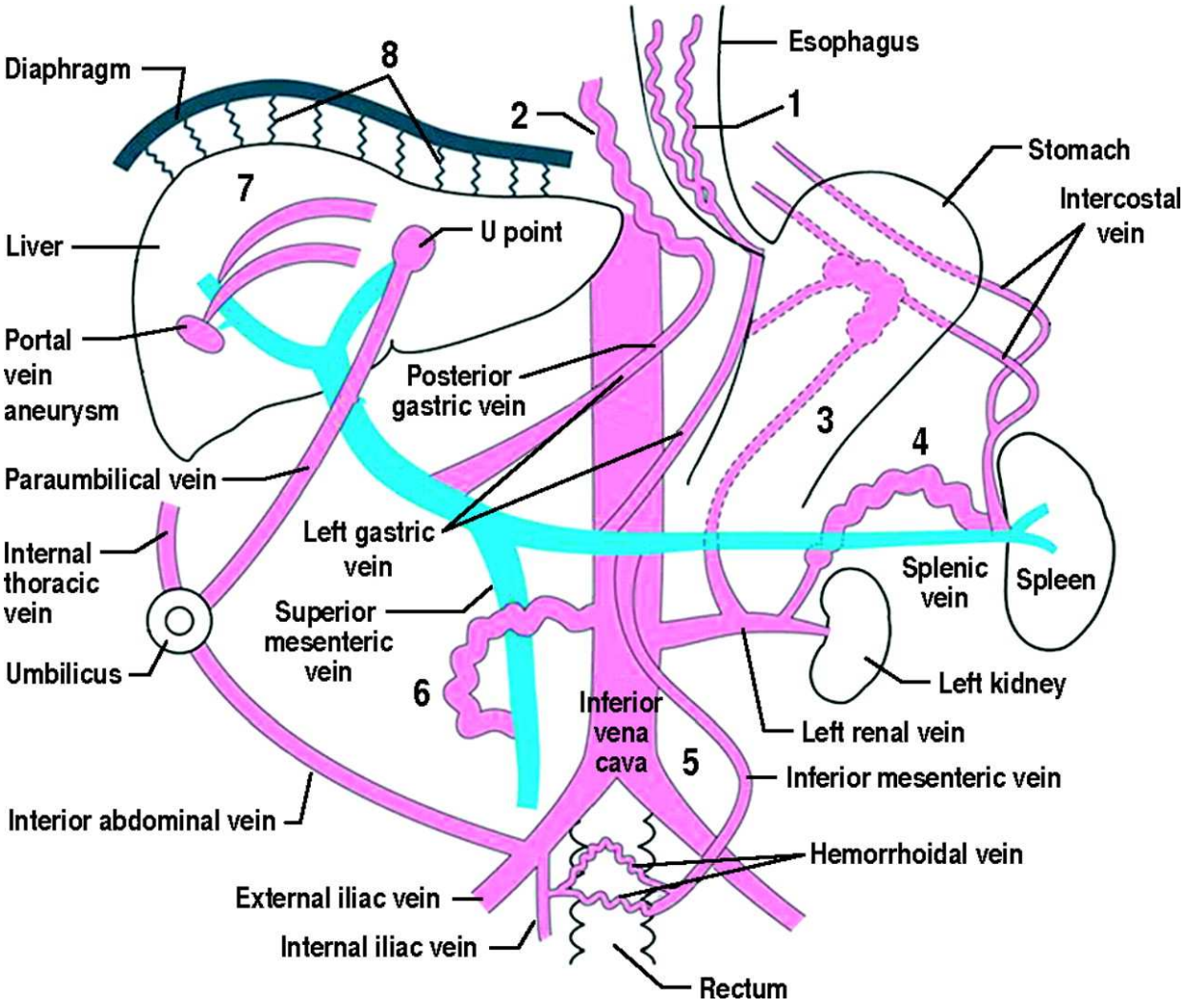
The postprandial portal blood flow rise is inversely related to severity of portal hypertension and liver cirrhosis and may be a valuable parameter with respect to the risk of variceal bleeding[8].

A prospective study to determine whether the measurement of portal flow velocity by Duplex-Doppler, compared with endoscopic data conducted by Cioni G, showed that portal flow velocity is unrelated to the degree of the Endoscopic abnormalities in patient with liver cirrhosis and that it has no value in the identification patients with cirrhosis at risk of upper gastro intestinal bleeding[20].

An experimental study in an animal model with portal vein –stenotic rat and high-grade Porto systemic shunting, indicates that hyper dynamic portal venous inflow, not resistance, provided the main impetus for maintaining elevated portal venous pressure. This splanchnic hemodynamic observation directly supports "forward flow" theory of portal hypertension[31].

Esophageal Varices:

A cute hemorrhage from esophageal varices in patients with liver cirrhosis carries a high early mortality rate even when emergency therapy is performed . The presence of large varices is generally considered the most important risk factor in the prediction of esophageal variceal bleeding .



Esophagoscopy is the standard technique for assessing the severity of varices and predicting the first esophageal hemorrhage. However. serial monitoring of fragile patients in end-stage liver disease with this semiinvasive approach is not without problems, and some patients refuse repeated studies because of discomfort.Endoscopy with independent noninvasive or invasive methods has been advocated to improve the available prediction system for variceal bleeding. The role of the more hazardous invasive techniques has not been established because investigators have not reached an agreement about the

relationship of portal pressure and variceal bleeding . Even the commonly held view that a portal pressure gradient of 12 mm Hg in patients with cirrhosis is the threshold below which variceal hemorrhage does not occur has recently been questioned by Jalan *et al*., who found that in 15% oftheir study population, variceal hemorrhage occurred despite a pressure gradient of less than 12 mm Hg. Doppler sonography is an attractive. Noninvasive alternative that provides useful functional information to augment the structural information of gray-scale imaging[32].

Bolande L *et al*. I have recently shown that evaluation of portal hemodynamics with Doppler sonography allows prediction of the risk of variceal bleeding. This quantitative approach is unlikely to achieve widespread clinical application because of the complexity of conditions that must be fulfilled to obtain reliable results. Doppler sonography is an accurate and accepted method in many clinical fields when qualitative flow data are investigated[33].

Postprandial changes in portal hemodynamics in cirrhosis patients with and portal hypertension:

Previous studies have shown that in patients with cirrhosis and portal hypertension, fasting portal venous blood flow is Increased as a result of decreased splanchnic precapillary resistance, mediated by a variety of metabolic, neural, and humoral mechanisms.' This increase in portal venous blood flow is associated

with an increase in intrahepatic vascular resistance resulting from lobular architectural disruption, and is a major factor determining the increase in portal venous pressure observed in these patients.3 Several studies in humans have shown an increase in portal venous pressure after a meal, an effect which is more noticeable in patients with cirrhosis and portal hypertension. This exaggerated postprandial increase in portal venous pressure in cirrhotic patients may result from either a meal stimulated increase in splanchnic and hence portal venous blood flow, an increase in intrahepatic vascular resistance, or a combination of these effects[34].

The results of this study show that after a high protein meal the hepatic venous pressure gradient and total hepatic blood flow increased by 33% and 69% respectively and were associated with a 31% reduction in hepatic vascular resistance[35].

The postprandial increase in total hepatic blood flow observed in this study is, likely to be predominantly related to an increase in portal venous blood flow[33].

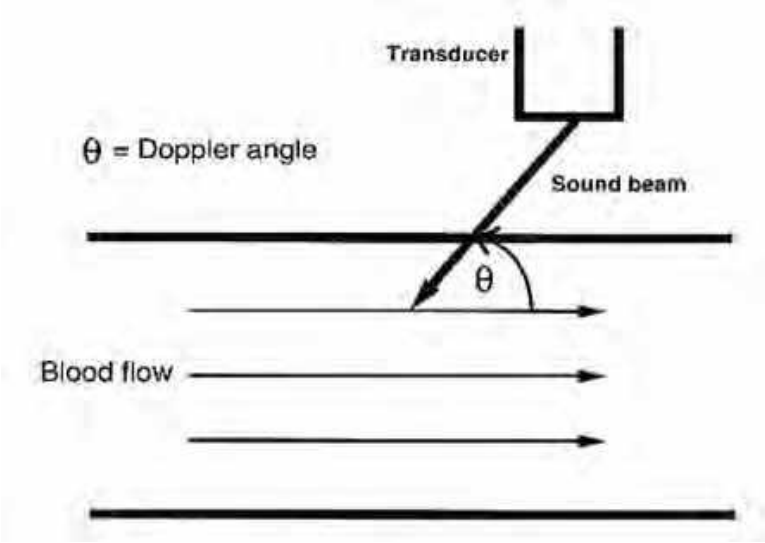
The case control study between the patients with chronic hepatitis with ultrasonagraphic evidence of liver cirrhosis with the normal volunteers (controls) by Zardi EM *et al* conformed that post meal portal flow velocity (PFV) increases in both healthy individual and in patients with chronic hepatitis, while in cirrhotic patients no significant changes occurs further this study conclude that monitoring

the blood flow in cirrhotic patients before and after administration of a standard liquid meals might be a suitable test to evaluate potential disturbances of flow itself[13].

In an operator blind design study by Sabba C showed a blunted hyperemic response to food in cirrhotic patients and significantly increased portal vein area were seen after the meal from 30 mins to 150 mins also concluded that in cirrhotic postprandial hyperemia was mainly related to increase in mean velocity[36].

Doppler flow measurement:

Doppler indices are calculated from the Doppler spectrum and enable indirect examination of vascular resistance in blood vessels with pulsatile flow. *Physical principles of Doppler technique:* the probe emits beams of ultrasound, which reflect against the moving particles, i.e. erythrocytes in the blood vessel (Figure 3). The beams then return into the probe, resulting in a change of frequency of the ultrasound wave (Doppler- effect). The Doppler signal is transformed into a spectrum which can be analyzed (systolic, diastolic, average flow velocity, volume flow, direction of blood flow, resistance index RI and pulsatile index PI) [37].



Doppler Effect provides a unique capability for ultrasound to measure blood flow. Upon insonification by an ultrasound beam, the echoes scattered by blood Carry information about the velocity of blood flow. Blood flow measurements are frequently performed on in a clinical environment to access the state of blood vessels and function of an organ. Ultrasonic Doppler instrument allows a measurement of instantaneous blood flow velocity. Conventionally two different approaches have been used for ultrasonic Doppler Flow measurement: continues wave (CW) and pulsed wave (PW) Doppler[37].

Non directional continuous wave flow meters:

A probe consisting of two piezoelectric elements, one for transmitting the ultra sound signal and one for receiving echoes return from the blood, is excited by an oscillator. The Doppler –shifted echoes are amplified demodulated and band-pass filtered to remove the carrier freq and other spurious signal.

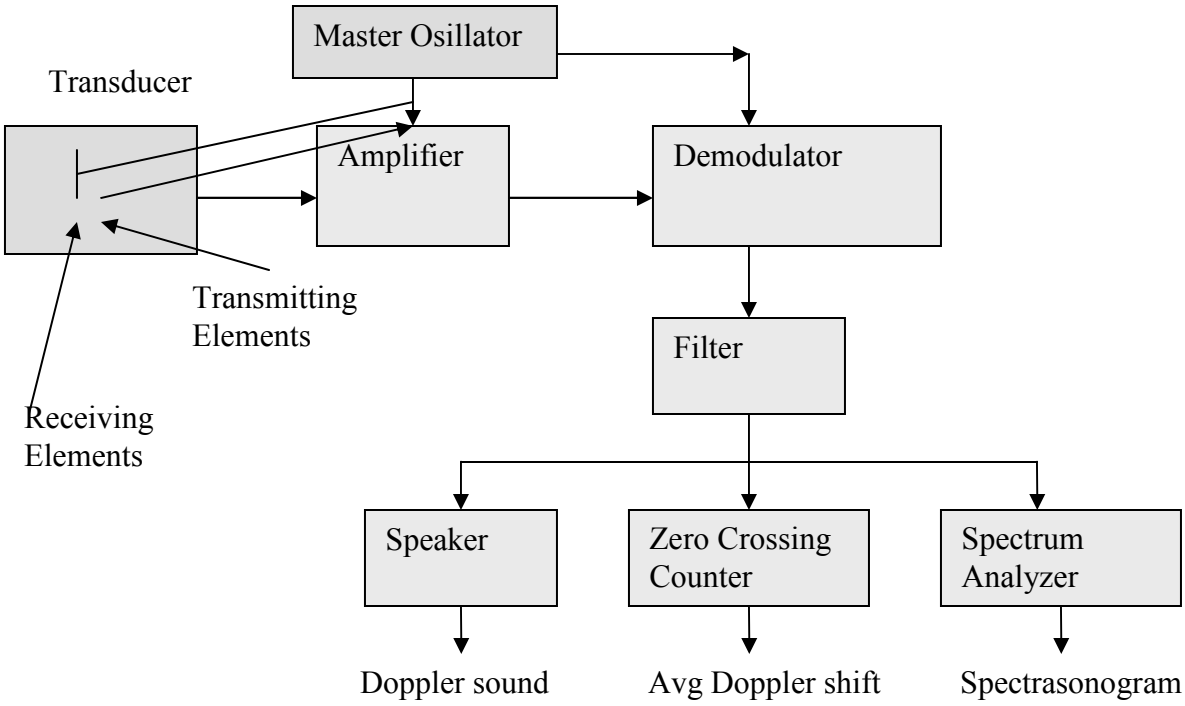


Fig 1: Block diagram of a CW Doppler flow meter

A problem in Ultrasonic Doppler Blood Flow measurement is that blood vessels that produce large reflected echoes r slow moving as well. In Doppler terminology, these large slow moving echoes are called clutter signals. The cut-off frequency of the band-pass filter at the low end must be designed to minimize the interference the clutter signal. The design of this band –pass filter in low freq region that perform the function of High pass (also called clutter rejection) filter have been problematic because the magnitude of the clutter signal is several orders higher than those from blood and may mask those from slow moving blood. Filters

with a very steep slope are a method that carries some forms of echoes cancellation may be used.

The signal after band-pass filtering can be processed in different ways. It may be heard with the speaker because Doppler shift in the audible range. Alternatively, a zero crossing counter can be used to estimate the mean Doppler freq or a spectrum analyzer can be used to display the spectrum.

The Spectrum is usually displayed in the format (fig 2) in which the vertical axis indicates Doppler freq or velocity, the horizontal indicates axis time, and gray scale indicates the intensity of Doppler signal at the freq or velocity. At each instant of time, the line displayed represents the Doppler spectrum at that time within a 5 to 10 ms time window. Form the Doppler spectrum the mean freq or other freq (e.g., median frequency) where the Doppler power spectrum is split into two equals halves and mode freq, where the Doppler power is the highest, can be readily estimated. [37]

Doppler method seems to be reliable not only for the in vivo measurement of rapid hemodynamic variations of portal system, such as, for eg for those determine by meals, by hormones and by drugs, but it proved to be reliable also for the measurement of portal flow velocity and volume at longer time intervals and among different operators, provided that the same equipment used and that operators are skilled and hard train together.

Doppler sonography is the most affordable method to measure noninvasively the main characteristics of mesenteric blood flow. Despite some well-known drawbacks such as operator dependence, many studies have documented a tolerable intra observer and inter observer variability[11].

Hepatic venous pressure gradient measurement by hepatic vein catheterization is the gold standard technique for the assessment of portal pressure changes in postprandial period in patients with cirrhosis.

However, this procedure is costly, is uncomfortable for the patients and is not available in every Hepatology unit. The development of a non-invasive test for monitoring portal hemodynamics has been the subject of debate ever since the importance of portal pressure in cirrhotic patients was established. The increase in portal pressure in the postprandial period may initiate variceal bleeding in cirrhotic patients. Therefore, it is important to identify patients who experience increased postprandial hyperemic response, and treat these patients appropriately. Echo-

Doppler ultrasonography is a non-invasive test which is widely used to determine portal blood flow. By contrast, echo-Doppler ultrasonography (USG) is inexpensive, easy for the patients and is available in most hospitals[36].

Sabba *et al* studied the sensitivity of echo-Doppler USG in detecting hemodynamic changes caused by postprandial hyperemia in an observer-blinded study[11].

Ultrasonagraphic parameters of portal hypertension show significant correlation between the diameters of portal vein and splanchnic vein. The portal hemodynamic parameter (blood flow velocity) is significantly related to the stages of liver damage, presence of ascites and Hepatic encephalopathy (HE), and while splenic hemodynamics is specific and directly related to this parameter. These findings suggest that left lobe of liver has a better postprandial complaints than the right lobe has. This concludes that quantitative duplex Doppler measurement of portal venous flow is mainly subjective non systematic variability[38].

Duplex ultrasound was used to investigate superior mesenteric artery hemodynamic in humans in order to study the contribution of small intestine to the postprandial to splanchnic hyperemia and to determine the relative potencies of the major food components in the postprandial mesenteric flow response.

Doppler USG is highly sensitive in detecting postprandial hemodynamic changes. Since hepatic venous pressure gradient measurement is the gold standard

for the evaluation of portal hemodynamic changes, postprandial portal blood flow increased significantly in patients who showed significant postprandial HVPG increase. Correlation analysis showed a strong correlation between postprandial PBV and hepatic venous pressure gradient[39].

Doppler ultrasonography of portal blood flow and portal flow volume (PFV) are useful to define changes in total hemodynamic of patient with chronic liver diseases. The meal test with post meal PFV measurement is generally accepted as a reproducible non invasive test to evaluate the severity of the PHT. It conclude that monitoring the portal blood flow in cirrhotic patients before & after administration of a standard meal might be a suitable test to evaluate potential disturbance of the flow itself[13].

Two blinded cross-over study using echo Doppler-flowmetry by Sabba'C *et al* in two group of subject

i) First group consisted of 21 patients with cirrhosis and 16 controls. They received standardized meal.

ii) Second group consisted of 31 patients with cirrhosis who received a dose of propranolol.

They suggested blood velocity alone monitor acute changes inflow in portal hypertension using Doppler flowmetry. The elimination of cross sectional area

measurement simplifies the quantitative calculation of portal hemodynamics and increases the reliability of technique by avoiding the source of error[40].

Doppler study was very sensitive in detecting splanchnic hemodynamic changes and difference between cirrhotic patient and normal subject.

Doppler parameters are recorded time averaged mean blood velocity, volume of the superior mesenteric artery. There was significant inverse correlation between portal, velocity and hepatic venous pressure gradient (HVPG), as well as between portal vein flow and HVPG.

Doppler ultrasound can provide important information on the hemodynamics of the portal venous system, the hepatic artery and the hepatic vein.

An operator - blind study with echo Doppler duplex system conducted by sabbac et- al proved that echo Doppler was very sensitive in deducting postprandial splanchnic hemodynamic changes and differences between cirrhotic patience and normal subject[36].

A prospective study was conducted by Cioni G emphasis the usefulness of duplex Doppler ultrasonagraphic in the non invasive diagnosis compensated cirrhosis[41].

A correlation study by A wiechowska et-al between quantative Doppler parameter and hepatic venous pressure gradient in alcoholic cirrhosis proved that

portal vein blood velocity and flow are correlated to the severity of portal hypertension under the severity of liver failure[39].

D' Alimonte P studied the utility of Duplex Doppler ultrasonagraphic in the evaluation of the portal hemodynamics in 52 patients with compensated liver cirrhosis exhibited the measurement of max PFV demonstrated a 76.6% sensitivity and a 100% specificity in detecting PH with 100% positive predictive value and 31% negative predictive value[35].

A double blind cross-over study by Cionic G *et al* using Duplex Doppler Ultrasonography (DDUS) in the evaluation of cirrhotic patient with portal hypertension and in the analysis of the response to drug suggested that the DDUS is the only non invasive method to study the drug efficacy in appropriate dosage and duration of treatment for portal hypertension[42].

MATERIALS AND METHODS

Study populations:

This study included 32 healthy volunteers from the age group of 52 to 74 years (62-63) males are selected. They were examined clinically and had no known gastrointestinal disorder and no diabetics or peripheral vascular disease and they were not taking any kind of medication.

Another group of 20 patients from the age group of 54-76 (65-66) who were all clinically, biochemically, endoscopically and ultrasonagraphically proven cases of cirrhosis with portal hypertension were selected for this study. They were not having any cardiac disease or any other known systemic disease other than cirrhosis.

All participants gave written informed consent to take part in the study, which was approved by the ethical committee.

Instruments:

The instrument used in the study was color Doppler ultrasonagraphy (ALOKAA 600) with 3.75 MHz curvilinear and convex probe . the system is equipped with software to compute the time averaged velocity from the velocity spectral display after placement of calipers the Doppler sample volume was positioned the center of the vessel or at the point when it was designed. The sample width was selected to cover almost entire vessel diameter. Pulse repetition frequency was adjusted so as to not to exceed the limit of the displayed maximum

velocity. Care was taken to ensure that the angle of insonation was always smaller than 60 degree.

Study Protocol:

All the healthy subject abstained from eating the night before ultrasonagraphic study. The cirrhotic patients also fasted overnight before the examination and the medications which are altering the hemodynamic parameters have been stopped at least three days before the study.

The healthy volunteers were divided into two groups each of 16 in numbers. One group was studied portal flow velocity in the fasting and also in the post prandial period of 15,30,45,60 and 90 minutes intervals after eating the solid meal, which contain 450 kilo calories of energy (4 idli's each having 50 gms of weight with dhal and chutney).

Another group of healthy volunteers were ingested 270ml of a standardized liquid meal (Ensure plus powder) after a basal period. The meal contained 16.7 % protein, 30% fat and 53.3% carbohydrate giving a total caloric value of 405 k cal (equivalent to 1648 kJ). Then they were involved in the Doppler study in serial time interval of 15, 30, 45, 60 and 90 minutes after the basal recording in the fasting state.

The cirrhotic patients who were selected in the study are divided into two groups. One group was given the same calorie solid meal as like healthy volunteers

in group one and another group of cirrhotic patients were ingested Ensure plus powder of same calorie and studied the portal flow velocity in different time interval period in each group after recording a basal measurement.

Doppler measurement:

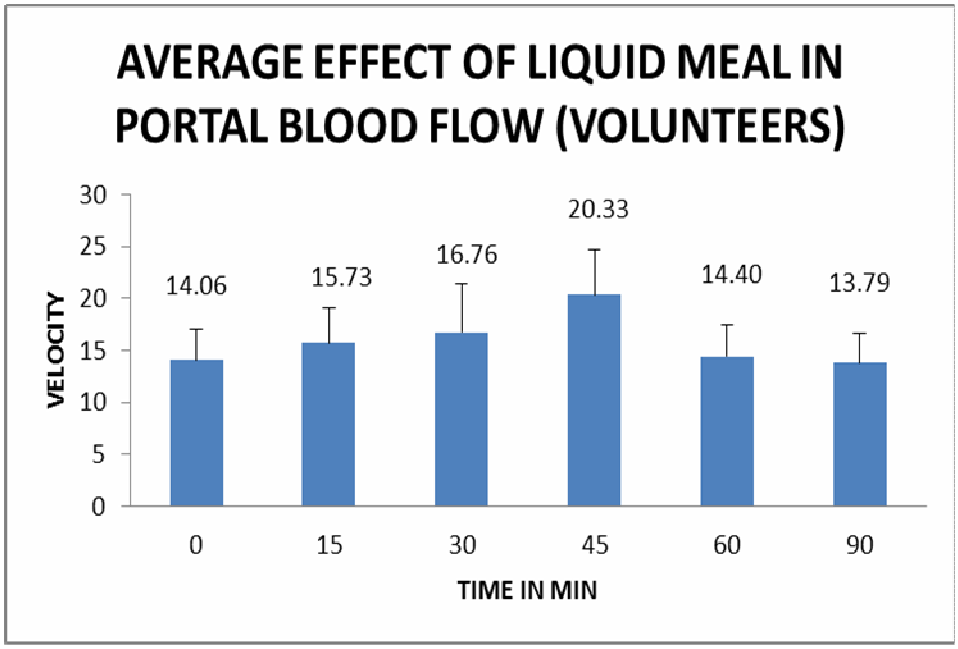
Each subject was examined after overnight fasting in supine position after a rest of 15 minutes so as to avoid any influence of food , posture and exercise . Overall assessment of the hepato- biliary system by B mode was made before Doppler examination. Then portal vein was identified near the bifurcation of hepatic artery. The whole length hepatic vein was traced and the middle of the hepatic vein selected by an appropriate anatomic window in the angle of not less than 60 degree. The flow direction was identified by color hue which is used to encode the greater frequency shift. The axial size of sample volume was adjusted to encompass the portal vein lumen in its entirely middle third. The time averaged mean flow velocity of portal vein was calculate d automatically by the instrument after tracing of the spectral display (single cardiac cycle) , where as maximum and minimum velocity were calculated manually .

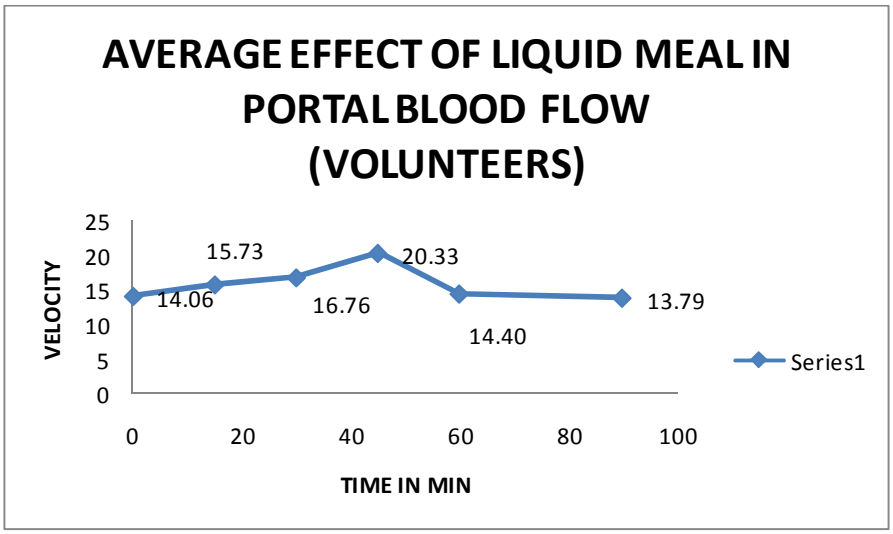
Measurement of time averaged maximum velocity of the portal flows were done at least twice for each side and the average were used for the further studies.

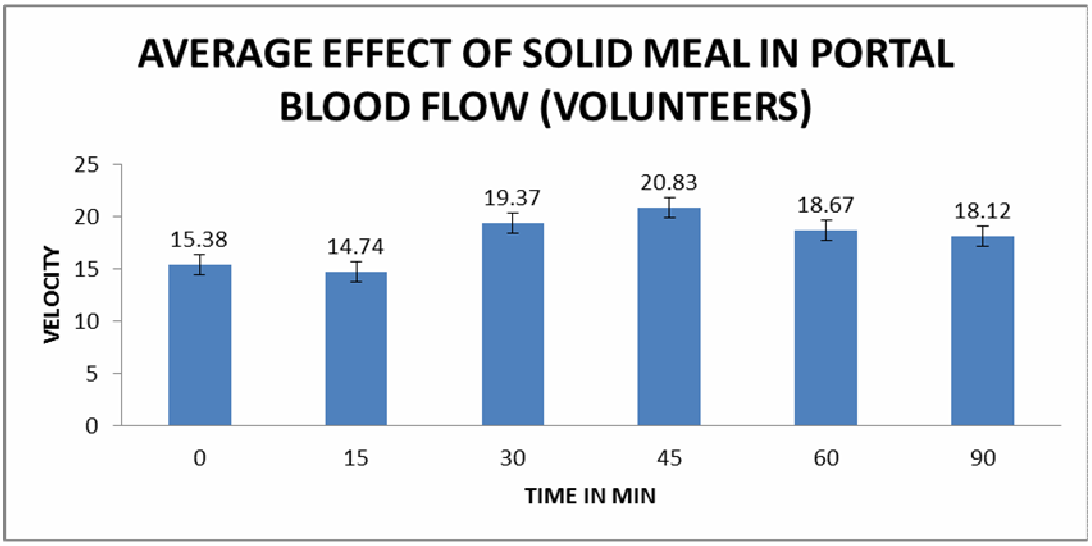
These measurements were also repeated in 30, 45, 60 and 90 minutes intervals with the same patient and the observations were recorded. In each group the measurement of portal flow velocity also recorded in the same manner.

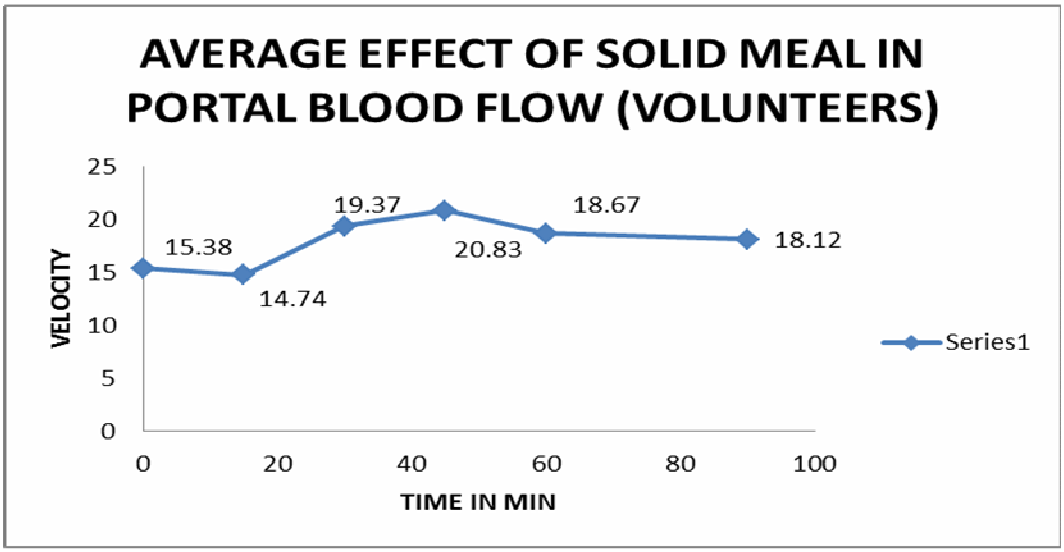
RESULTS AND OBSERVATION

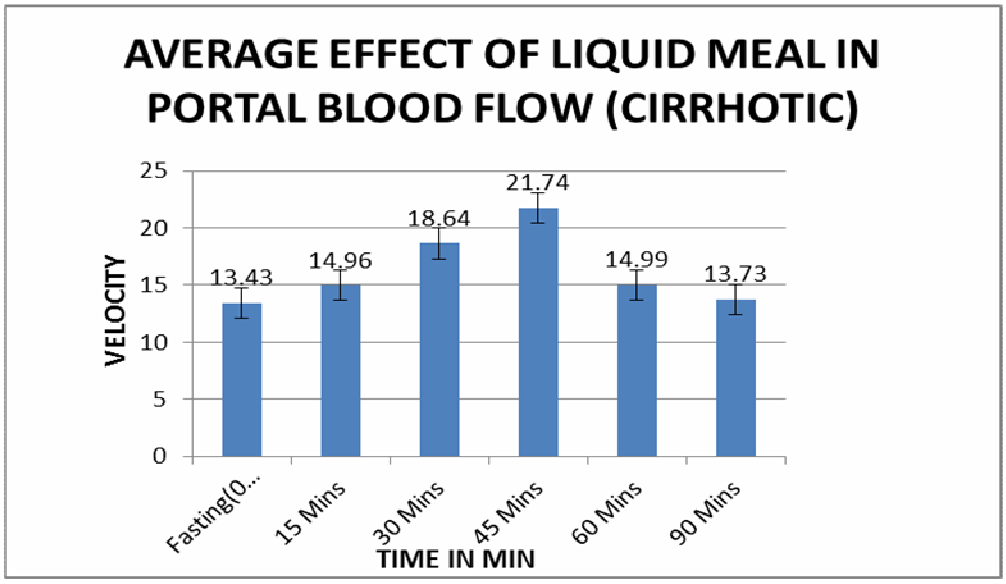
Study group	Portal flow velocity(PFV) Cm\Sec											
	Fasting (0 mins)		15 Mins		30 Mins		45 Mins		60 Mins		90 Mins	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Normal volunteers												
Liquid Meal	14.06	2.97	15.73	3.42	16.76	4.66	20.33	4.31	14.40	2.99	13.78	2.87
Solid meal	15.38	2.31	16.74	2.39	19.37	2.19	20.83	2.16	18.67	1.53	18.12	1.55
Cirrhotic Humans												
Liquid Meal	13.43	3.76	14.96	3.41	18.64	4.06	21.74	4.10	14.99	3.68	13.73	3.58
Solid meal	13.07	2.57	14.17	2.74	17.07	2.71	19.43	2.87	16.64	1.81	16.13	1.85

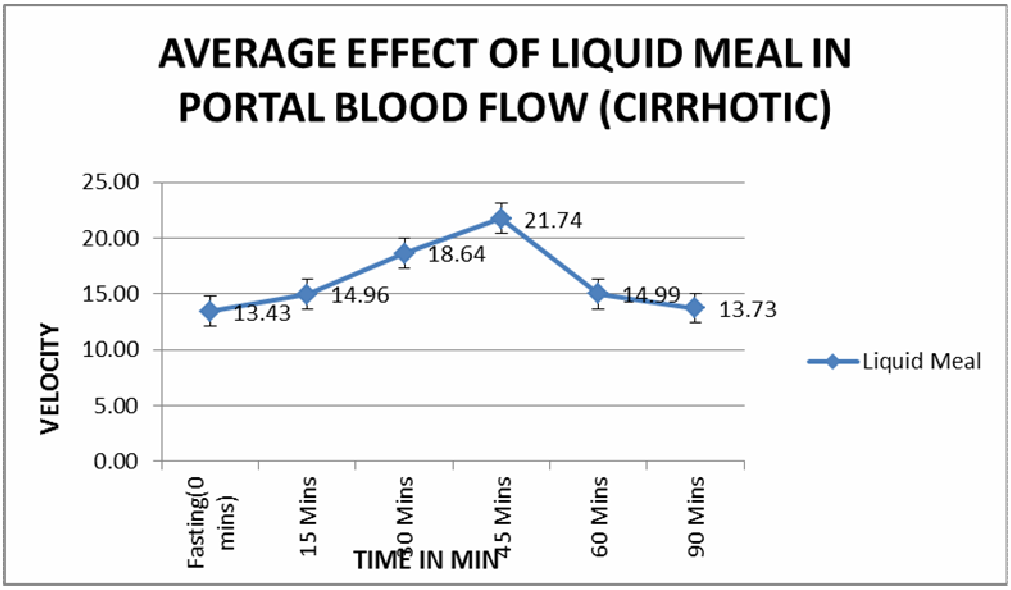

AVERAGE EFFECT OF LIQUID MEAL IN PORTAL BLOOD FLOW (VOLUNTEERS)
VELOCITY
30
25
20
15
10
5
0
14.06
15.73
16.76
20.33
14.40
13.79
0
15
30
45
60
90
TIME IN MIN

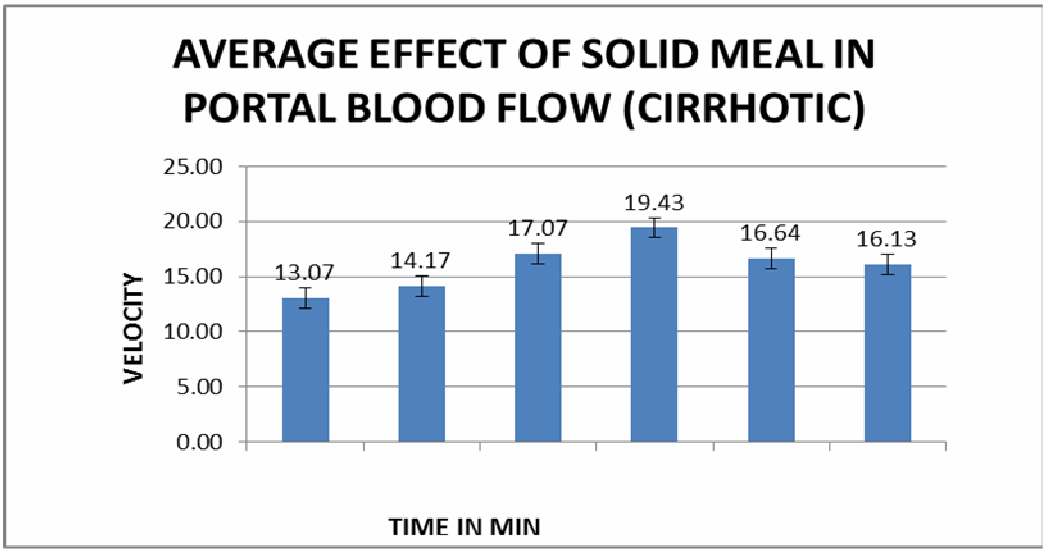

AVERAGE EFFECT OF LIQUID MEAL IN PORTAL BLOOD FLOW (VOLUNTEERS)
VELOCITY
25
20
15
10
5
0
14.06
15.73
16.76
20.33
14.40
13.79
0
20
40
60
80
100
TIME IN MIN
Series1

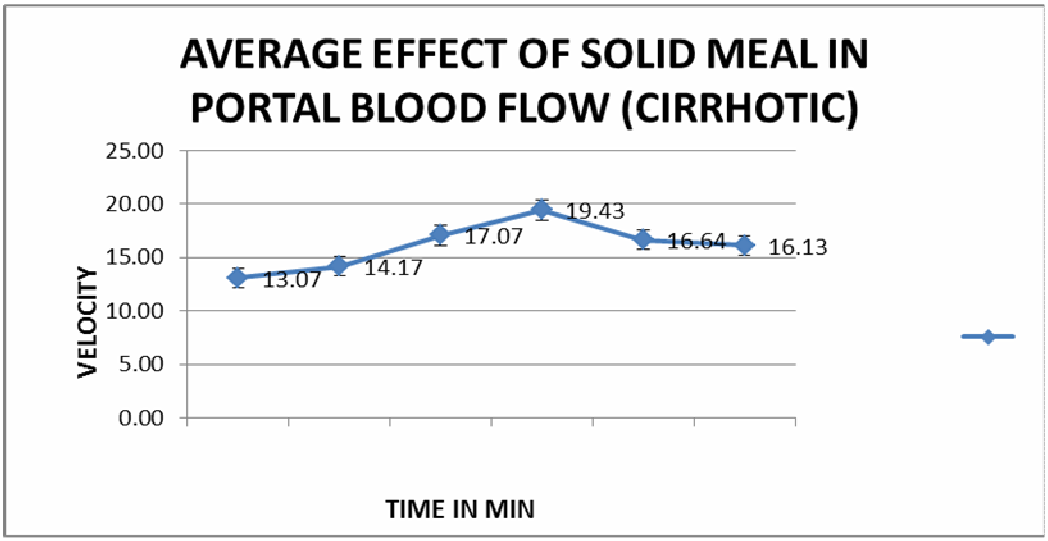

AVERAGE EFFECT OF SOLID MEAL IN PORTAL BLOOD FLOW (VOLUNTEERS)
VELOCITY
25
20
15
10
5
0
15.38
14.74
19.37
20.83
18.67
18.12
0
15
30
45
60
90
TIME IN MIN


AVERAGE EFFECT OF SOLID MEAL IN PORTAL BLOOD FLOW (VOLUNTEERS)
VELOCITY
25
20
15
10
5
0
15.38
14.74
19.37
20.83
18.67
18.12
0
20
40
60
80
100
TIME IN MIN
Series1


AVERAGE EFFECT OF LIQUID MEAL IN PORTAL BLOOD FLOW (CIRRHOTIC)
VELOCITY
25
20
15
10
5
0
13.43
14.96
18.64
21.74
14.99
13.73
Fasting(0...
15 Mins
30 Mins
45 Mins
60 Mins
90 Mins
TIME IN MIN


AVERAGE EFFECT OF LIQUID MEAL IN PORTAL BLOOD FLOW (CIRRHOTIC)
VELOCITY
25.00
20.00
15.00
10.00
5.00
0.00
13.43
14.96
18.64
21.74
14.99
13.73
Liquid Meal
Fasting(0 mins)
15 Mins
30 Mins
45 Mins
60 Mins
90 Mins
TIME IN MIN


AVERAGE EFFECT OF SOLID MEAL IN PORTAL BLOOD FLOW (CIRRHOTIC)
25.00
20.00
15.00
10.00
5.00
0.00
VELOCITY
13.07
14.17
17.07
19.43
16.64
16.13
TIME IN MIN


AVERAGE EFFECT OF SOLID MEAL IN PORTAL BLOOD FLOW (CIRRHOTIC)
25.00
20.00
15.00
10.00
5.00
0.00
VELOCITY
13.07
14.17
17.07
19.43
16.64
16.13
TIME IN MIN

Study group	P Value				
	0 vs. 15	0 vs. 30	0 vs. 45	0 vs. 60	0 vs. 90
Normal volunteers					
Liquid Meal	P> 0.05	P> 0.05	P< 0.001	P> 0.05	P> 0.05
Solid meal	P> 0.05	P< 0.001	P< 0.001	P< 0.001	P< 0.01
Cirrhotic Humans					
Liquid Meal	P> 0.05	P<0.05	P< 0.001	P> 0.05	P> 0.05
Solid meal	P> 0.05	P< 0.01	P< 0.001	P<0.05	P> 0.05

liq-solid comparison in normal group

Time interval B\W Liq & Sol	P Value
0 Sol vs. 0 Liq	0.3986
15 Sol vs 15 Liq	0.434
30 Sol vs. 30 Liq	0.3957
45 Sol vs. 45 Liq	0.4163
60 Sol vs. 60 Liq	0.0991
90 Sol vs. 90 Liq	0.0802

liq-solid comparison in cirrhosis group

Time interval B\W Liq & Sol	P Value
0 Sol vs. 0 Liq	0.4736
15 Sol vs 15 Liq	0.4819
30 Sol vs. 30 Liq	0.4155
45 Sol vs. 45 Liq	0.4631
60 Sol vs. 60 Liq	0.2815
90 Sol vs. 90 Liq	0.3312

comparison of liq meal B\W normal & cirrhosis

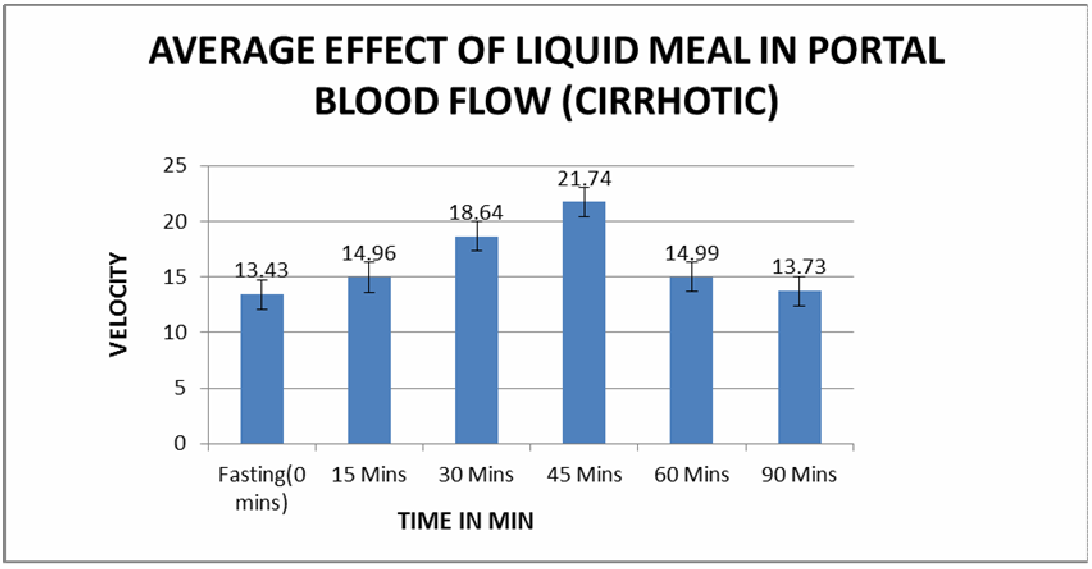
Time interval B\W Liq & Sol	P Value
0 Sol vs. 0 Liq	0.2697
15 Solvs 15 Liq	0.429
30 Sol vs 30 Liq	0.2863
45 Sol vs 45 Liq	0.4264
60 Sol vs 60 Liq	0.4149
90 Sol vs 90 Liq	0.3477

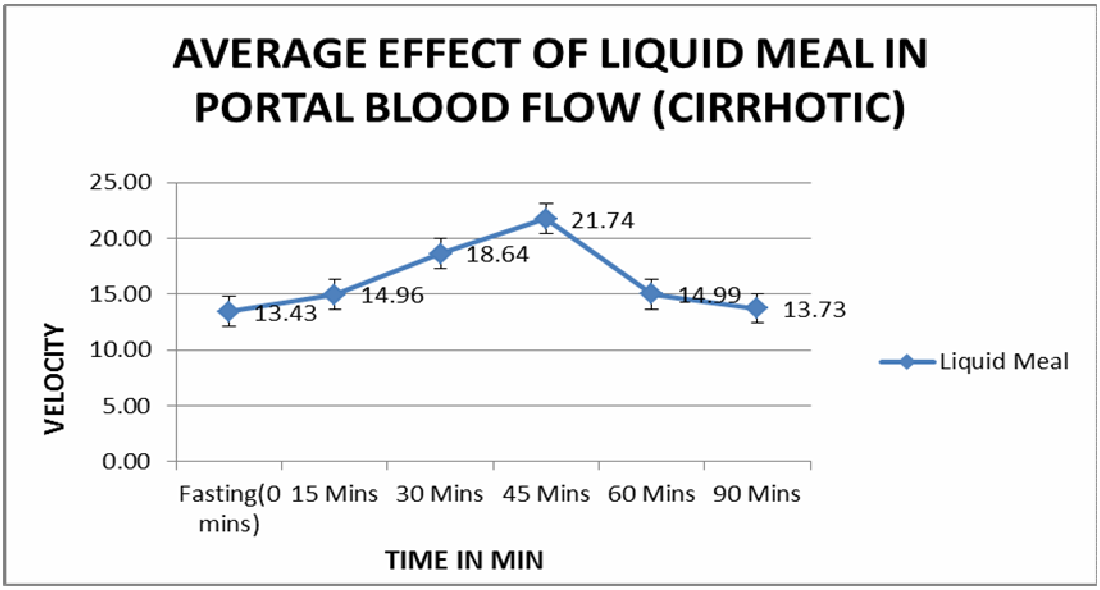
comparison of sol meal B\W normal & cirrhosis

Time interval B\W Liq & Sol	P Value
0 Sol vs 0 Liq	0.2327
15 Solvs 15 Liq	0.2364
30 Sol vs 30 Liq	0.3643
45 Sol vs 45 Liq	0.2872
60 Sol vs 60 Liq	0.0845
90 Sol vs 90 Liq	0.2222

Cirrhotic Humans

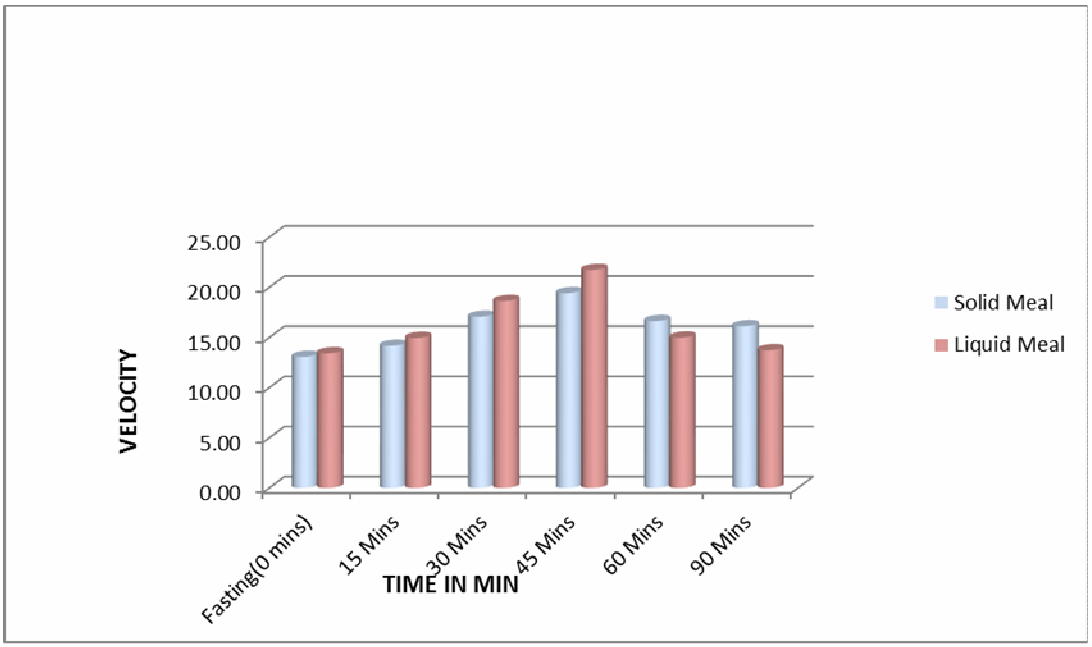
Liquid Meal	Fasting (0 mins)	15 Mins	30 Mins	45 Mins	60 Mins	90 Mins
AVG	13.43	14.96	18.64	21.74	14.99	13.73
SD	3.76	3.41	4.06	4.10	3.68	3.58

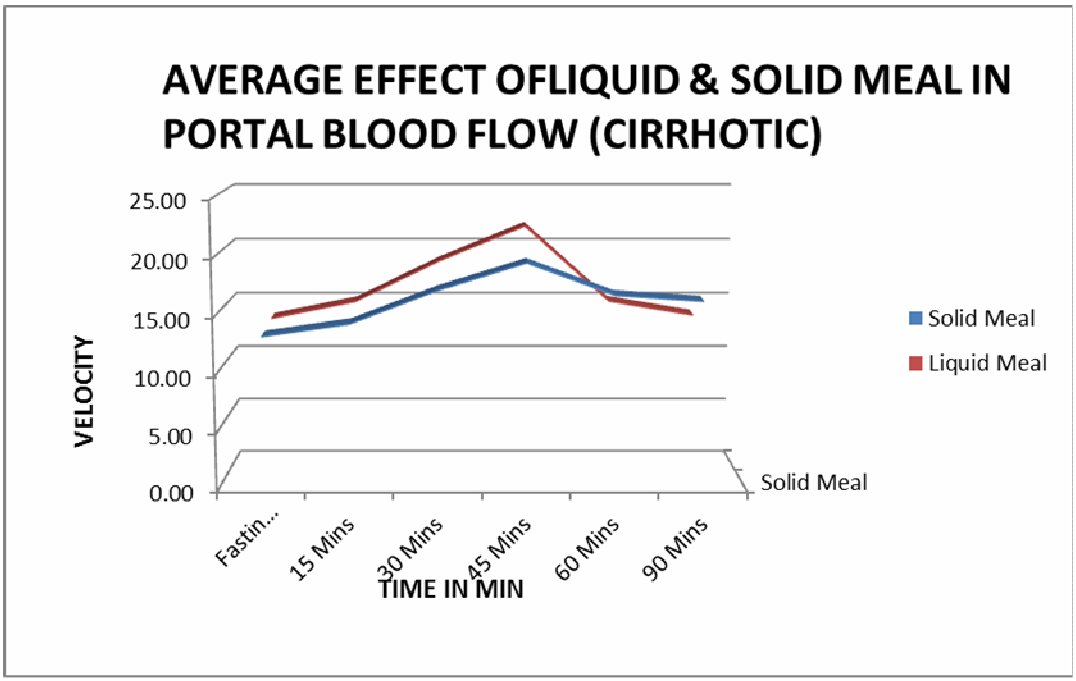

AVERAGE EFFECT OF LIQUID MEAL IN PORTAL BLOOD FLOW (CIRRHOTIC)
VELOCITY
25
20
15
10
5
0
13.43
14.96
18.64
21.74
14.99
13.73
Fasting(0 mins)
15 Mins
30 Mins
45 Mins
60 Mins
90 Mins
TIME IN MIN


AVERAGE EFFECT OF LIQUID MEAL IN PORTAL BLOOD FLOW (CIRRHOTIC)
VELOCITY
25.00
20.00
15.00
10.00
5.00
0.00
13.43
14.96
18.64
21.74
14.99
13.73
Fasting(0 mins)
15 Mins
30 Mins
45 Mins
60 Mins
90 Mins
TIME IN MIN
Liquid Meal

Comparison between solid and liquid with cirrhosis

	Fasting (0 mins)	15 Mins	30 Mins	45 Mins	60 Mins	90 Mins
Solid Meal	13.07	14.17	17.07	19.43	16.64	16.13
Liquid Meal	13.43	14.96	18.64	21.74	14.99	13.73





STATISTICAL ANALYSIS

Statistical analysis was done after tabulating using MS Excel sheet s using SPSS version 15.0. Posthoc analysis was done for comparison within the group, one way ANNOVA and one sample “t” test was used for intergroup comparison. $P<0.05$ is considered significant. Finally the results were tabulated. The charts were prepared using MS Excel sheets.

DISCUSSION

Interest in the portal circulation has grown very rapidly in recent years, but data in man have been rare because of technical problems in measuring splanchnic blood flow in humans. The introduction of the ultrasonic color Doppler technique has been an important breakthrough in the evaluation of splanchnic hemodynamics. Quantitative evaluation of portal blood flow measurements has made it possible to study the relation between liver function and portal blood flow in health and disease.

Color Doppler study is an excellent non-invasive method of study to evaluate the postprandial blood flow velocity which can be easily reproducible and it can be carried in electronic version as real time study. This method also gives consistent and reproducible result after the physiological stimuli such as food intake.

Though the studies have shown that velocity, diameter and blood flow are decreased after subjects shifting their position from supine to sitting, Cioni G *et al* suggested strongly that Doppler Ultrasonography is the only non-invasive method for examination of the portal vein system[42].

Though parameters detected by Doppler sonography in the portal system most valuable (portal vein diameter, Time averaged flow velocity, portal flow volume and congestion index) in identifying meal stimulated portal flow changes in healthy individuals , portal hypertension and it severity.By

Sabba .C. *et .al* suggested blood velocity alone is used to monitor acute changes in flow in portal hypertension using Doppler flowmetry[43].

Attempt have been made to correlate increased vessel diameter with the presence or absence of portal hypertension(Doust and pearce in 1976; Abdel Lathef *et al*.1981;Bolande *et al*.1982;Weinreb *et al*. 1982). It can be seen that statement made about portal vein diameter may be misleading unless the relationship of timing of the measurement to the absorptive status of the patient is known [48].

D'Alimonte P *et al* demonstrated the measurement of portal flow velocity by Doppler ultrasonagraphy in the assessment of portal hypertension showed 76.6 sensitivity and a 100% specificity in detecting portal hypertension, with 100% positive predictive value and 31% negative predictive value[35].

In the present study portal vein the mean portal vein velocity are significantly increased from the baseline value of 15.38cm\sec to a maximum value of 20.83 at 45 min after a solid meal and also had a significant increase in velocity was seen after 30 min(19.36)compared with baseline value. This study also found that there is no significant change in the baseline value of PFV in all four groups.

Findings of this study also comparable with studies by Lau Sieng Chuo et-al[6] in healthy Malaysian adult population(portal blood flow velocity is

increased 28.48±7.79 cm/sec, 30 minuets after a meal from the basal value of 21.17± 8.15.

Gorlberg, *et al*. have shown that there were increment on total volume flow, velocity and diameter 15 minutes after meal ingestion. Differences on increment of portal vein velocity after meal ingestion mainly are due to dynamics variability of gastric emptying [6].

The increase in the gastrointestinal blood flow in post prandial state depends on either an increased cardiac output, a shunting of blood from less active tissue to the gastrointestinal tract or combination of two3. Traditionally it is belived that the majority of this response is due to the chemical stimuli from components of the hydrolyzed food such as glucose and fatty acid as well as gastrointestinal secretions. The possible regulations behind nutrient induced hyperemia in mammals has been reviewed extensively. Few studies have considered the importance of mechanical distension of stomach and intestine in regulation of gut blood flow in mammals[3].

Henrik Seth et-al studies concluded that in animal model that mechanical distention of stomach induces an instantaneous alpha adrino receptor mediator aortic blood pressure with no change in cardiac output, gut blood flow or heart rate[3].

This study also found that, there is an increase in PFV in 16 healthy volunteers after liquid meal in 45 minutes (20.33 ± 4.3 cm/sec) and less

significant increase of PFV after 30 minutes (16.76 ± 4.66 cm/sec) from the basal value of 14.05± 2.9 cm/sec.

This study also found that, there is an increase in PFV in 16 healthy volunteers after liquid meal in 45 minutes (20.33 ± 4.3 cm/sec) and less significant increase of PFV after 30 minutes (16.76 ± 4.66 cm/sec) from the basal value of 14.05± 2.9 cm/sec.

In the present study after the ingestion on liquid meal, there is a significant increase in the portal blood flow after only 45 mins. This increase in the portal blood flow velocity (PFV) de crease after 60 mins and reaches the basal after 90 mins.

The initial lack of increase in PFV might be due to less distension of stomach by liquid meal and by single exponential emptying of gastric contents into the duodenum.

The marked increase in PFV after 45 minutes might be due to chemical stimulation by the constituent of liquid meal to facilitate digestion and absorption in the small intestine.

The decrease in PFV in 60 mins is due to clearance of vasodilators released as by product on food and metabolic activity of gut is cleared by normally functioning liver.

The further decrease in PFV at 90 mins might be buffering action of hepatic arterial blood flow which is required for supply of oxygen to the liver for its metabolic activity.

Several studies on cirrhosis with portal hypertension by Doppler ultrasonography revealed portal flow velocity is one of the Doppler parameter used to identify the severity of the portal hypertension, stages of the liver disease , early detection of esophageal variceal bleeding and drug effcicacy.

Perisic M *et al* showed a significant correlation between portal flow velocity with the stages of liver damage, presence of ascites and Hepatic Encephalopathy (HE) [44].

Patrice Taourel *et al* also showed that portal hemodynamic parameters (BFV) are correlated to the severity of portal hypertension and to the severity of liver failure[39].

There are variable results have been seen in the relation between PFV and esophageal variceal bleeding.

Huang *et al* suggested a Doppler velocity profile (PFV) is a valuable parameter in predicting esophageal variceal bleeding[30].

Cionic *et al* strongly suggested that portal flow velocity is not related to the degree of endoscopic abnormalities in patients with liver cirrhosis and that it has no value in identification of cirrhosis at risk of upper gastrointestinal bleeding[45].

The meal study is performed in cirrhotic humans. In this group the PFV increased only after 45 mins on postprandial period in liquid meal and decrease after 45 mins and attain basal level at 60 mins which is comparable as with normal volunteers.

Findings of the above results is comparable with studies of Sabaa C *et al*. who showed a significant insreace in portal blood flow in normal healthy individuals after 30 minutes to 150 minutes but the cirrhotic patient showed a blunted hyperemia[36] .

The meal test with post meal PFV measurement is generally accepted as a reproduciable non-invasive test to evaluate the severity of portal hypertension.

Zardi EM *et al* conformed that post meal PFV increases in both healthy individuals and patient with chronic hepatitis, while in cirrhotic patient no significant changes occurs[13] .

The above results are comparable with the present study which showed increase in PFV after the solid meals in 30 minutes and persistently increase only upto 60 minutes (P value < 0.001) in normal volunteers the PFV further increase is seen upto 90 min.

To compare with the liquid and solid meals in cirrhotic patients showed a increase in PFV only at 45 minutes while taking liquid meals but there is a persistant increase of PFV from 30 minutes to 90 minutes in solid meals.

This comparative study also well correlate with the results of study in normal healthy volunteers.

Assessment of patients with the significant increase in post prandial allows the use of several treatment option.it was recently obsereved that administration of low dose isosorbide mononitrate attenuate post prandial hyperemia . by contrast, propronalol is ineffective in blunting post prandial hyperemia but has some effects in reducing post prandial portal blood flow .

Therefore , it is important to identify patient who experience increase post prandial hyperemic response, and treat this patients approximately. Color Doppler ultrasonography is the non invasive test which is widely used to determine portal blood flow velocity.

It is believed that an increase in collateral circulation prevents postprandial rise in portal pressure despite increased blood flow in the splanchnic area.

These results support the use of the techniques mainly for the determination of rapid and large changes in portal hemodynamics within a short period of time. This technique seems to have low precision in monitoring chronic changes in portal hemodynamics.

Comparative study conducted by Osman Ozdogan, et-al observed that patients who showed postprandial increase in HVPG also demonstrated an increase in the parameters by echo-Doppler ultrasonography[46].

Another prospective study by sabbac et-al on feasibility spectrum for Doppler flowmetry of splanchnic in normal and cirrhotic population demonstrated that physical factor (weight, age, sex and height) affect the Echo Doppler Feasibility (EDF) normal individuals but not in cirrhotic patient[47].

A comparative study on portal vein blood flow in anesthetized dog using either pulsed Doppler echo system or electromagnetic flow meters by Dauzat M et-al demonstrated Doppler flowmetry is probably not an ideal method to measure absolute portal vein blood flow values, and more sophisticated equipment is needed to improve its reproducibility and accuracy. However in humans this method might be a useful tool to access the direction of portal flow changes in the same individual[48].

Though there were studies both in human and animal models proved that significant change in gastric emptying in between solid and liquid meals, very few studies demonstrated change in portal flow velocity by using Doppler sonography.

This study also documented the sudden spike of PFV at 30 min in normal healthy volunteers, which could be due to the effect of stomach distension mediated by stretch receptors which are vagally mediated and not due to parasympathetic vasodilator effects.

This study also recorded the persistent increase in the PFV in 45 min, 60mins and also in 90 min in solid meals. This might be slow gastric emptying of solid meal compared with mono exponential emptying of liquid meal.

This persistent increase in PFV might be diversion of blood from the systemic circulation which is centrally mediated and this impairs the blood flow to the muscle of upper and lower limbs and also the brain which is the causative factor for post prandial drowsiness in humans.

The study on solid meal revealed increase PFV immediately after 30 min as like normal volunteers. The increase in PFV persist in 45 min and 60 min it decrease in; 90 min and did not attain the basal level.

The first immediate increase in PFV in cirrhotic patient on solid meal might be normal functioning stomach which mediates and divert the systemic blood flow into the portal circulation.

The further increase in PFV in cirrhotic humans at 45 min and 60 min is might be vasodilatation mediated by normally functioning gut into the portal circulation.

The fall in PFV at 90 mins in cirrhotic humans compare with normal volunteers could be the established Porto systemic collateral circulation which can accommodate large volume of blood which is diverted from the portal circulation.

Long period of increase in PFV may divert the blood from the systemic circulation into the collateral circulation is the main cause for low blood volume and low blood pressure.

Further increase in blood flow into the collateral may lead to rupture of varies and produces gastro-esophageal bleeding.

The large number in studies proved that sudden spike in PFV is dangerous for ruptured esophageal varieas in the postprandial period.

Death is inevitable if large volume of blood is lost from the collateral circulation due to sudden rupture of esophageal varices, because the long standing cirrhotic patient having dysregulated homeostatic mechanism[1].

This study observe that there is less increase in portal flow velocity in liquid meals than persistant increase in PFV on solid meals in healthy volnteers.

This study also found there is less increase in portal flow velocity both in liquid and solid meals compared with the healthy volunteers.

SUMMARY

- This study has been done in the department of Radiology, Coimbatore Medical College and Hospital, Coimbatore.

The subject were in

- Group 1- Healthy volunteers (Divided into two groups)
- Group 2- Cirrhotic patients with portal Hypertension (Divided into two groups)
- Solid or Liquid meal were administered to each group

- The Liquid meal administered the healthy volunteers and cirrhotic patients were studied portal flow velocity by Doppler ultrasonography.

- The Solid meal administered the healthy volunteers and cirrhotic patients were studied portal flow velocity by Doppler ultrasonography.

- The liquid meal administered healthy volunteers and cirrhotic patients compared the portal flow velocity in Fasting, 15 min, 30 min, 45 min, 60 min and 90 min time intervals were recorded.

- The solid meal administered healthy volunteers and cirrhotic patients compared the portal flow velocity in Fasting, 15 min, 30 min, 45 min, 60 min and 90 min time intervals were recorded.

- All the data were compared with one way ANOVA and student's' test.

CONCLUSION

From this study, it could be concluded that

1. This study also observed time dependant change of portal flow velocity in all four groups.

2. The portal blood flows were slightly varied in healthy volunteers and cirrhotic patients.

3. The portal flow velocities increased after 30 min in solid meal and persistently increase in 45 min.

4. The post prandial increase of portal flow velocity was seen only after 45 min in liquid meals.

5. There is no change in portal flow velocity was seen in fasting state of all the groups.

6. In statistical studies, the one way ANOVA and student ‘t’ test the solid meal found more significant than liquid meal.

LIMITATIONS OF THIS STUDY

The limitation of the study is that the difficulties were felt while shifting the patient from ward to Ultrasound scan room for a short time interval frequently.

The huge ascites masking the Ultrasound window to detect the portal vein .

The immediate change of position from standing to supine will affect the portal flow velocity temporarily.

FUTURE SCOPE OF THE STUDY

The future scopes of the study are

- Prospective study to evaluate the post prandial increase in different stages of the cirrhosis with portal hypertension.
- To evaluate the effect of liquid meal on systemic circulation in post prandial period.

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PROFORMA

THE EFFECT OF SOLID AND LIQUID MEAL ON POST PRANDIAL PORTAL VEIN FLOW VELOCITY IN HEALTHY VOLUNTEERS AND CIRRHOSIS PATIENT WITH PORTAL HYPERTENSION

NAME :

AGE :

SEX :

ADDRESS :

BLOOD PRESSURE:

PR:

HISTORY OF ANY SURGERY :

HISTORY OF DRUG INTAKE :

HISTORY OF ANY PHERIPERAL

VASCULAR DISEASE :

HISTORY OF ANY CARDIAC ILLNESS :

CONSENT FORM

Dr.A. Moorthi, Post Graduate student in the Department of Physiology,Coimbatore Medical College,Coimbatore-14 .studying

THE EFFECT OF SOLID AND LIQUID MEAL ON POST PRANDIAL PORTAL VEIN FLOW VELOCITY IN HEALTHY VOLUNTEERS AND CIRRHOSISPATIENT WITH PORTAL HYPERTENSION.

The test procedure of color Doppler ultrasonography of abdomen was explained to me clearly. I understand there are no risk involved in the above procedure. I hereby give my consent in this study the data obtained herein may be used for research and publication.

Signature:

Name:

Place:

EFFECT OF LQUID FOOD

S.no	LIQUID MEAL		PORTAL BLOOD FLOW VELOCITY CM/S					
	AGE	**CODE**	**0**	**15**	**30**	**45**	**60**	**90**
1	54	V1	8.1	8.8	9.3	15	8.6	8.4
2	58	V2	9.3	10.1	11.6	15.8	9.4	9.1
3	62	V3	12.5	21.5	14.8	17.1	12.4	11.8
4	56	V4	15.1	16.8	18.4	20.1	15.3	14.5
5	72	V5	17.2	18.1	19.3	21.5	17.4	16.8
6	76	V6	19.9	20.3	30.9	34.2	20.3	19.7
7	58	V7	15.5	16.8	17.3	19.5	15.1	15.8
8	65	V8	13.3	14.8	16.1	20.8	13.5	13.8
9	59	V9	16.1	17.8	18.2	22.1	16.5	15.8
10	65	V10	14.3	15.8	16.7	19.3	14.8	11.7
11	57	V11	11.1	11.8	12.5	17.3	11.5	11.5
12	58	V12	13.3	14.8	15.3	18.2	13.8	13.8
13	65	V13	15.2	16.8	17.5	21.3	15.8	14.3
14	70	V14	12.5	13.2	14.8	19.3	13.1	12.8
15	53	V15	15.2	16.8	17.1	21.5	16.1	15.3
16	74	V16	16.3	17.5	18.4	22.3	16.8	15.4
		AERAGE VALUE	14.06	15.73	16.76	20.33	14.4	13.78
		SD	2.966	3.417	4.658	4.315	2.991	2.867

* ***V*** *- Volunteers*

EFFECT OF SOLID

S.no	SOLID MEAL		PORTAL BLOOD FLOW VELOCITY CM/S					
	AGE	**CODE**	**0**	**15**	**30**	**45**	**60**	**90**
1	69	V1	14.3	15.5	17.3	18.5	16.1	15.3
2	54	V2	16.3	17.5	18.8	19.4	17.3	17.2
3	55	V3	13.2	14.4	16.8	17.5	16.8	15.9
4	62	V4	17.1	18.2	19.3	21.1	19.5	19.1
5	67	V5	15.2	16.1	18.2	19.8	17.2	17.1
6	70	V6	12.5	13.8	16.4	18.4	16.5	16.1
7	64	V7	17.3	18.5	22.5	24.3	20.1	19.3
8	58	V8	14.5	16.1	21.8	22.8	19.3	18.9
9	52	V9	16.3	17.5	19.8	22.1	20.1	19.8
10	50	V10	10.3	12.1	17.5	19.3	19.1	17.2
11	63	V11	13.1	14.8	17.3	18.2	17.1	16.8
12	59	V12	15.7	16.3	19.2	21.1	20.1	19.5
13	54	V13	16.3	17.8	19.5	21.8	19.8	19.2
14	72	V14	18.2	19.3	22.5	23.8	19.3	19.2
15	74	V15	16.5	17.8	19.5	21.8	20.3	19.5
16	62	V16	19.3	22.1	23.5	23.4	20.1	19.8
			15.38	16.74	19.37	20.83	18.67	18.12
			2.308	2.393	2.191	2.157	1.53	1.553

* ***V*** *- Volunteers*

S.no	LIQUID MEAL		PORTAL BLOOD FLOW VELOCITY CM/S					
1	AGE	CODE	0	15	30	45	60	90
2	58	P1	19.9	20.3	26.2	27.8	21.5	20.3
3	70	P2	8.1	9.5	12.3	13.5	9.3	8.5
4	57	P3	13.2	15.5	17.3	21.5	14.8	13.5
5	62	P4	10.2	11.3	14.5	20.2	12.3	11.4
6	54	P5	17.2	18.1	22.4	26.3	18.4	17.1
7	68	P6	11.4	15.4	17.3	22.5	15.6	12.9
8	71	P7	13.5	14.8	18.5	22.6	14.3	14.2
9	64	P8	16.8	17.5	21.9	23.2	17.2	16.1
10	54	P9	9.5	11.1	16.5	17.3	10.4	9.1
11	65	P10	14.5	16.1	19.5	22.5	16.1	14.2
		AVERAGE	13.43	14.96	18.64	21.74	14.99	13.73
		SD	3.757	3.411	4.058	4.104	3.677	3.583

* *P - Patients*

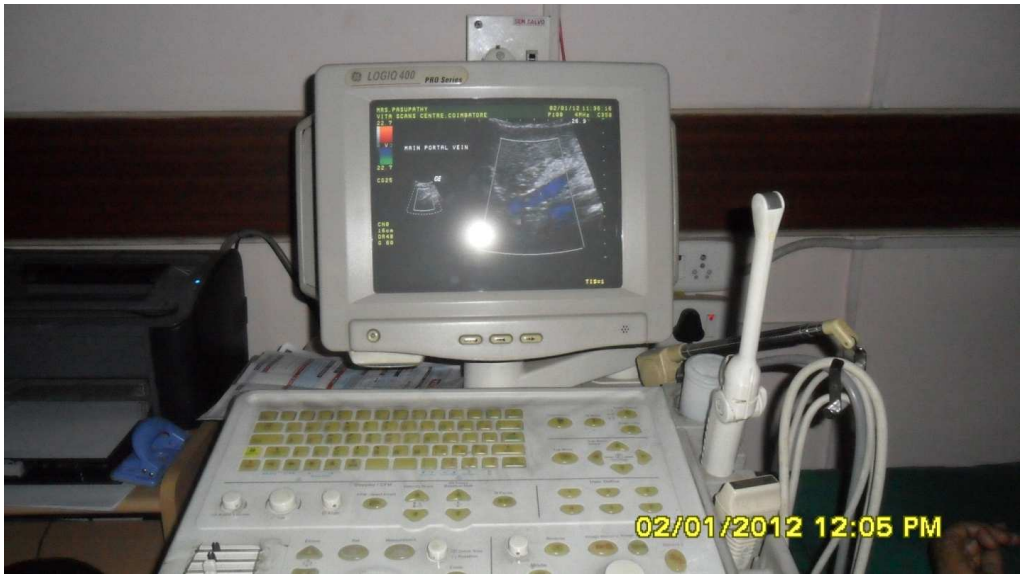
S.no	SOLID MEAL		PORTAL BLOOD FLOW VELOCITY CM/S					
1	AGE	CODE	0	15	30	45	60	90
2		P1	11.5	12.3	15.8	18.3	17.5	16.8
3	70	P2	12.8	14.1	17.3	19.1	16.3	15.8
4	58	P3	18.1	19.3	22.5	25.1	19.5	19.3
5	55	P4	13.5	14.8	17.3	19.1	16.5	16.1
6	70	P5	15.5	16.8	19.5	21.8	18.5	17.8
7	76	P6	10.5	11.3	15.4	18.3	16.1	15.8
8	58	P7	11.5	12.8	14.5	17.3	15.5	14.8
9	64	P8	14.5	16.1	18.3	21.6	17.3	16.5
10	58	P9	13.5	14.1	17.3	19.2	16.4	16.2
11	60	P10	9.3	10.1	12.8	14.5	12.8	12.2
		AVERAGE	13.07	14.17	17.07	19.43	16.64	16.13
		SD	2.57	2.739	2.714	2.87	1.806	1.852

** P - Patients*

Doppler Scan by Sonologist

Doppler Scan by Investigator

Colour Doppler – Ultra Sonography



Spectral Analysis