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The Portal Vein and Liver Portography Utilizing the Umbilical Vein*

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THE umbilical vein can be dilated to permit a catheter to be passed into the left porta hepatis. This catheter permits aspiration of blood, measurment of portal vein pressure, outline of the portal vein, and branches of the porta hepatis, collaterals, and outline of the liver. The clinical application of this procedure is presented.

This can be done under local anesthesia as an independent extraperitoneal procedure or while the abdominal cavity is opened. The catheterization procedure may be useful over seven to ten days or may be used for transient study over minutes depending on the needs of the surgeon. All ages of patients can be explored. These studies have been carried on since 1958 on well over 100 patients with no mortality and negligible morbidity. The problems of catheterizing this vein are probably no different from catheterizing the saphenous vein at the ankle.

The umbilical vein runs from the umbilicus through the falciform ligament and at an acute angle enters the left porta hepatis within the liver substance. This vein may already be distended and filled with blood in some cases of portal hypertension or it may be completely empty of blood. It is not thrombosed but rather is in a state of collapse and contraction due to collagen fibers.[1] At the umbilicus it may only be a few frayed threads but as it ascends cephaled below the midline fascia it usually becomes quite prominent to the size of 3 mm. to 5 mm. as it approaches the falciform ligament through which it enters into the liver substance. As it enters the falciform ligament the diameter is usually larger but not always. It is a firm grayish white cord with the consistency of the vas deferens and is more commonly flattened. This structure may be quickly identified or it may be hidden within the properitoneal fat below the midline fascia, slightly to the right of the midline. In search of this vein one may occasionally have to tease the properitoneal fat to find the structure. It may be necessary to pick up all of the properitoneal fat between the thumb and index finger to palpate it or to feel the tight cord as the fatty tissue is put under tension.

Familiarity with the structure and the procedure can be obtained during upper abdominal surgery for other operations. On occasion para-umbilical veins will be quite distended and full, and while these may be used for temporary study, for more prolonged study perhaps the tougher thicker umbilical vein is a better structure.

The surgical procedure[2] is to make a small longitudinal midline incision centered at the junction of the middle and lower third of the distance from the xiphoid to the umbilicus. This incision

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varies anywhere from one to three inches depending on the size of the patient and the size of the liver. This incision is developed through the midline fascia which retracts. The umbilical vein is easily picked up by elevating the areolar and fatty tissue in this area. The areolar tissue is not transected but rather one teases the fat and areolar tissue from a tight band that is grasped in this area. On occasion the vein may stay quite small until it approaches the falciform ligament from which it is easily pulled out with a little traction. When the cord is separated from the fatty areolar tissue, it is put on traction and cleaned of this fatty areolar tissue so that the structure is easily outlined. On opening this vein transversely as in a saphenous vein cutdown, it is wise to stay as caudad as possible (consistent with size) to permit preferably one inch of vein cephalad so that if the vein is accidently torn or lost a more cephalad position on the vein can be utilized for catheterization. The vein is transversely incised about 40 per cent to 60 per cent of its structure. On allowing the edges of the incised vein to retract one usually sees a small lumen, and more commonly a drop of blood in the lumen. To the inexperienced or when the lumen is in question it should be dilated caudad first to definitely identify the lumen of the structure. When introducing a small probe of 1 mm. to 2 mm. in diameter, the lumen of the vein is now dilated cephalad for about one inch, and with progressive-sized Hegar type of dilators the lumen is stretched up to about 5 mm. in diameter. This one inch dilatation of the vein is performed so that one to three hemostats may be placed about the periphery of the vein to maintain exposure while the remainder of the procedure follows.

A probe measuring 2 mm. to 3 mm. in diameter is then directed along the lumen of the vein at about a 40° angle toward the hilus of the liver. This probe is pushed with a constant definite force that would be utilized in pressing a hemostat through the external fascia in a herniorrhaphy. When the probe has gone about four to five inches an impulse is given, much as would be experienced in dilating the sphincter of Oddi. At this stage one has entered the left porta hepatis and blood most commonly comes back through the lumen of the umbilical vein. When this impulse is received the distance that the probe has entered through the lumen of the vein should be measured so that the catheter can be inserted at least this far if a monitoring of the portal blood or pressure is to be maintained. Before the catheter is introduced, if blood does not come back through the umbilical vein, one may milk the exposed umbilical vein and a drop of blood will be seen. If one is interested only in an outline of the portal vein and porta hepatis or liver, the catheter may be introduced only into the previously dilated umbilical vein.

Following progressive dilatation of the umbilical vein to 5 mm. to 7 mm. in diameter a polyethylene tubing is then introduced to about one inch beyond the point of impulse. The size of the catheter to be used should be at least 2 mm. to 3 mm. on its inside diameter if free egrees of blood is to be maintained at any desirable time. Rarely, slight irrigation of the catheter with saline will promptly produce free egress of blood. This is probably due to some physical impact of the end of the catheter against the porta hepatis. One should not be tempted to bevel the edge of the polyethylene tubing for ease of administration as this results only in a laceration of the umbilical vein and creates a false passage. A suction type of polyethylene tubing with an adapter for a syringe on one end with the other terminal and completely patent is used. A catheter is then lightly tied into and around the umbilical vein with plain catgut. The second tie which also does not constrict the tubing is utilized to tie the catheter into the midline fascia so that one does not inadvertently pull the catheter out of the vein. This also maintains the catheter extraperitoneal since the thought of retrograde oozing upon removal of the catheter may be of some concern. No unusual oozing or bleeding upon withdrawal of the catheter after it has been in place more than a day has occurred. The catheter is removed half-way into the umbilical vein for 12 hours to permit the vein to collapse before fully withdrawing the catheter.

A technical difficulty may develop in the search of the umbilical vein if the approach is made too far cephalad so that entrance into the falciform ligament is made before finding the umbilical vein. On entering the falciform ligament the operator may be confused with other small venous structures and fibrous tissue which will be disconcerting. It is well to approach and search for the

umbilical vein by being more caudad than the falciform ligament. Retraction of the umbilical vein out of the falciform ligament is easily done. With the extraperitoneal approach all manipulations are more easily executed above the level of the fascia. If at any time there is concern about being in the lumen, 5 cc to 10 cc of 40 per cent Hypaque may be injected to see if there is extravasation. This is rarely necessary after one has experience with the procedure.

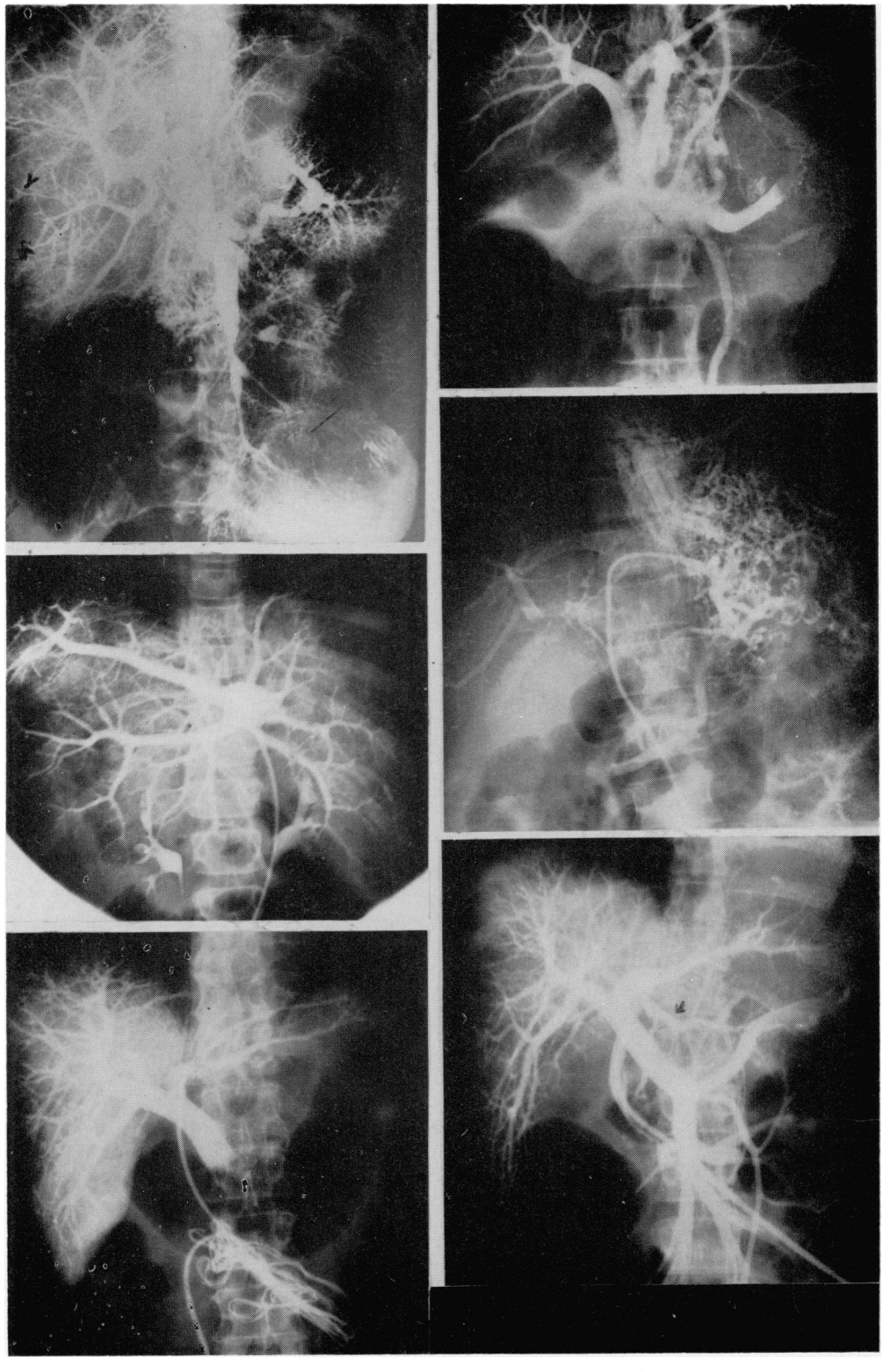
In portal hypertension the blood has free egress into the catheter and climbs up the catheter as it is elevated away from the abdominal wall. The measurement of the portal pressure whether normal or distinctly abnormal can be easily performed with a manometer. Usually there is free vacillation of the pressure in the portal vein. This vacillation is greater when portal elevation is not great but is most always present. When a large sized catheter as described is used there is egress of blood when the catheter is properly placed in the left porta hepatis.

If at this stage portal hypertension is not the problem but rather only an outline of the liver is desired contrasting material is injected into the porta hepatis. Twenty to 30 cc of 40 per cent Hypaque in 3 to 5 seconds is used and x-rays may be taken on the table or leisurely in the x-ray department later. It should be remembered that in the absence of portal hypertension any injected radiopaque material very rapidly disappears from the portal circulation. If an outline of the liver is desired x-rays should be taken after about 10 cc to 15 cc have been injected as another second elapses before the picture is taken. If serial x-rays are to be taken on rapid changers, the x-rays are taken at about 0.6 seconds apart for three or four seconds, and then perhaps one second apart for another six or seven seconds. It will be remembered that in the presence of portal hypertension the dye slowly disappears in the portal circulation and one can leisurely spend up to ten seconds taking the x-ray pictures. A small dose of a narcotic is given as the sudden injection of the medium causes transient discomfort in the abdomen.

An outline of the portal tree and system in a cadaver is seen in Fig. 1 which was a barium filled portal vein system. This orderly arrangement of the tributaries of the porta hepatis as seen in Fig. 1 demonstrates no portal hypertension. The outline of the portal tree is well known from studies by injecting the spleen. This method gives a clearer visualization of the liver in portal hypertension and a better picture of the liver when there is no portal hypertension because of the rapid injection of dye. The runoff of the normal portal pressure patient is so quick that a large amount of dye often needs to be injected to get good visualization of the liver outline.

Fig. 2 is one selected from rapid changer films in a 11-year-old girl who demonstrated portal hypertension (31 cm) on manometric readings and a beautiful enlargement of liver topography. Another slide, Fig. 3 is that of a 51-year-old man that shows a clear outline of the liver tree without the gnarling and tortuosity of far advanced cirrhosis, but because of the clear outline of the liver and the filling of the portal vein with a manometric reading of 17 cm pressure in the portal vein suggests early hypertension. If the portal vein had not been filled and these terminal branches of the porta hepatis not so sharply outlined one might not suspect mild cirrhosis of the liver with obstruction to the "run off".

There is considerable discussion in the literature as to the type of anastomosis one should attempt to do in decompression surgery of the portal system. Fig. 4 shows that the coronary vein primarily supplies the esophageal varices that are demonstrated. These periesophageal veins, however, may not always be filled from the coronary vein. There are other veins that may not be visualized in conventional studies and such are seen in Fig. 5. In this case the catheter was introduced inadvertently and perhaps fortuitously too far into the left porta hepatis so that as a result there is very rapid filling of the gastric veins and the esophageal veins from a vein in the left porta hepatis or hilar area. There is filling of the coronary vein as is seen but no filling of it from the portal vein. In this case perhaps a side-to-side anastomosis would better decompress the esophageal area than would have an end-to-side anastomosis. In Fig. 6 there is a large transhepatic vein that is easily demonstrated and is seen as X vein which clearly goes to the gastroesophageal area from the left porta hepatis. In this case, perhaps a side-to-side would better decompress this vein since obstruction in the liver is still present. In Fig. 7 following a



Figs. 1, 2, 3, 4, 5 and 6—legends on opposite page.

double barreled anastomosis, the umbilical vein was maintained patent and injected forcibly with dye. A large vein is seen running up toward the diaphragm from the porta hepatis. In the case of an end-to-side anastomosis perhaps this vein might not have been decompressed.

In Fig. 8 after an end-to-side anastomosis the umbilical vein was injected and a large vein is seen running medially all the way up to the periesophageal area. This vein was never adequately decompressed. The patient did have recurrent vomiting of blood and died two years later of recurrent hemorrhage. Perhaps this patient might better have had a side-to-side anastomosis rather than an end-to-side anastomosis.

This method may help us to decide which type of portal decompression to select. It may give us information as to why some portacaval anastomoses may result in failure with recurrent bleeding. It is more useful if a prior splenectomy has been done, Fig. 4.

The umbilical vein may also be used to demonstrate post shunt thrombosis when a side-to-side or spleno-renal type of anastomosis has been performed. Such patency can be seen in Figs. 9 and 10. In the case of a double barreled anastomosis only the proximal limb can be seen as in Fig. 7.

This approach may also be used in the case of suspected portal vein thrombosis in the infant or child where one would like to definitely demonstrate a normal liver. In Fig. 11 a three-year-old with recurrent hematemesis from esophageal varices was shown to have a normal pressure (10 cm), a normal porta hepatis and rapid runoff demonstrating a normal liver. The portal vein was not demonstrated and it could be assumed that it was thrombosed. The important thing is that the liver was normal and the child could probably tolerate recurrent bleeding episodes until the structures are large enough for surgical decompression. At the age of more definitive decompressive surgery a splenoportogram may be of more value but until then the risk of doing a splenoportogram is obviated with the resultant risk of splenic tear that might deny the use of the splenic vein in the future.

In cases of massive upper gastrointestinal bleeding with the diagnosis in question the umbilical vein approach to the determination of portal hypertension may be somewhat less risky than a splenic pulp reading. In the case of the massive bleeder this procedure while better intended in an operating room has been done in bed for confirmation in the diagnosis of bleeding.

The use of surgical Pitressin in bleeding from esophageal varices is well known. It is also known that surgical Pitressin can cause a rebound phenomenon. The use of the umbilical vein portal pressure monitoring can be of value in determining the efficacy of the drug. This was done in two patients.

In one patient, a drop over a period of six hours occurred before the portal pressure was again elevated. In the other patient, a drop of portal

Fig. 1. (left column, top) Barium filled portal system in cadaver taken in 1958. This shows the orderly bifurcation of the portal vein to the periphery of the liver.

Fig. 2. (left column, middle) Case 618723. Childrens Hospital. Female, 11 years old, portal pressure 310. Cirrhosis of the liver; typical vascular pattern of cirrhosis of the liver. This is one of a series of portograms taken with the rapid changer. Renal outline shown because the 15 cc of 40 per cent Hypaque had to be repeated when rapid changer failed to work the first time. X-rays were taken two days after the catheter was inserted through the umbilical vein. The catheter enters from 6 o'clock.

Fig. 3. (left column, bottom) Case 078899. Washington Hospital Center. Male, 51 years old, portal pressure 17 cm. Excellent outline of liver and filling of portal vein. Early cirrhosis (?) with obstruction to "run off" not characteristic of marked cirrhosis (compare with Fig. 4).

Fig. 4. (right column, top) Case 269651. Washington Hospital Center. Spanish female, 47 years old, had removal of spleen (hypersplenism). Had large coronary vein communicating with paraesophageal veins. Portal pressure 47 cm. Umbilical vein and catheter marked with broken line.

Fig. 5. (right column, middle) Case 122554. Prince George's Hospital. This preoperative film demonstrates the catheter higher in the left porta hepatis than is usually desired. The right porta hepatis is not visualized well nor is the portal vein. The large veins to the esophageal area suggest that an end-to-side anastomosis would not decompress these collateral veins that appear to arise beyond the end of the portal vein. Such collaterals should be compared to those of Fig. 4 where collaterals are developed from the coronary vein. Compare also with Fig. 6 that shows a large transhepatic vein.

Fig. 6. (right column, bottom) Case 664434. Washington Hospital Center. Female, 33 years old. Diagnosis—Cirrhosis of the liver. Drinking for 13 years. Portal pressure 25 cm. H_2O. This portogram outlines the system. Gnarling and tortuosity of the terminal veins of the porta hepatis are seen. Note the large transhepatic vein that would not be decompressed with an end-to-side shunt.

pressure from 330 to 240 in 15 minutes took place, but rebounded to 440 in 50 minutes and stayed elevated at 380 for two hours before returning to 330 mm in three hours. Another case previously mentioned, Fig. 2, an 11-year-old girl with cirrhosis and portal hypertension had an immediate rise in portal hypertension upon the administration of surgial Pitressin and the drug was discontinued.

It might be well to consider monitoring the portal pressure when surgical Pitressin is used, to determine the efficacy of the treatment; it is obvious that other drugs could be utilized in the research study for a drop in portal hypertension in

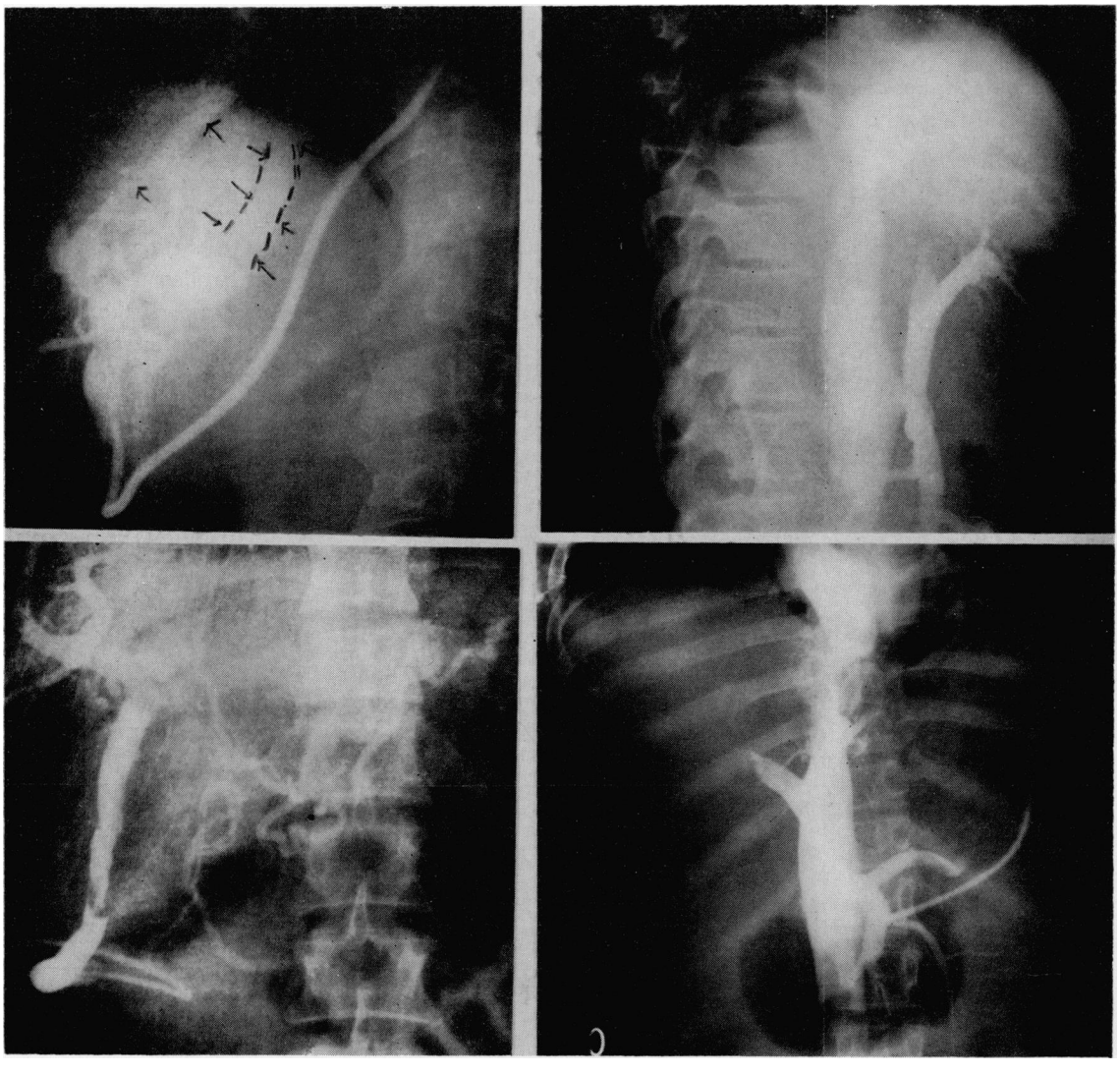
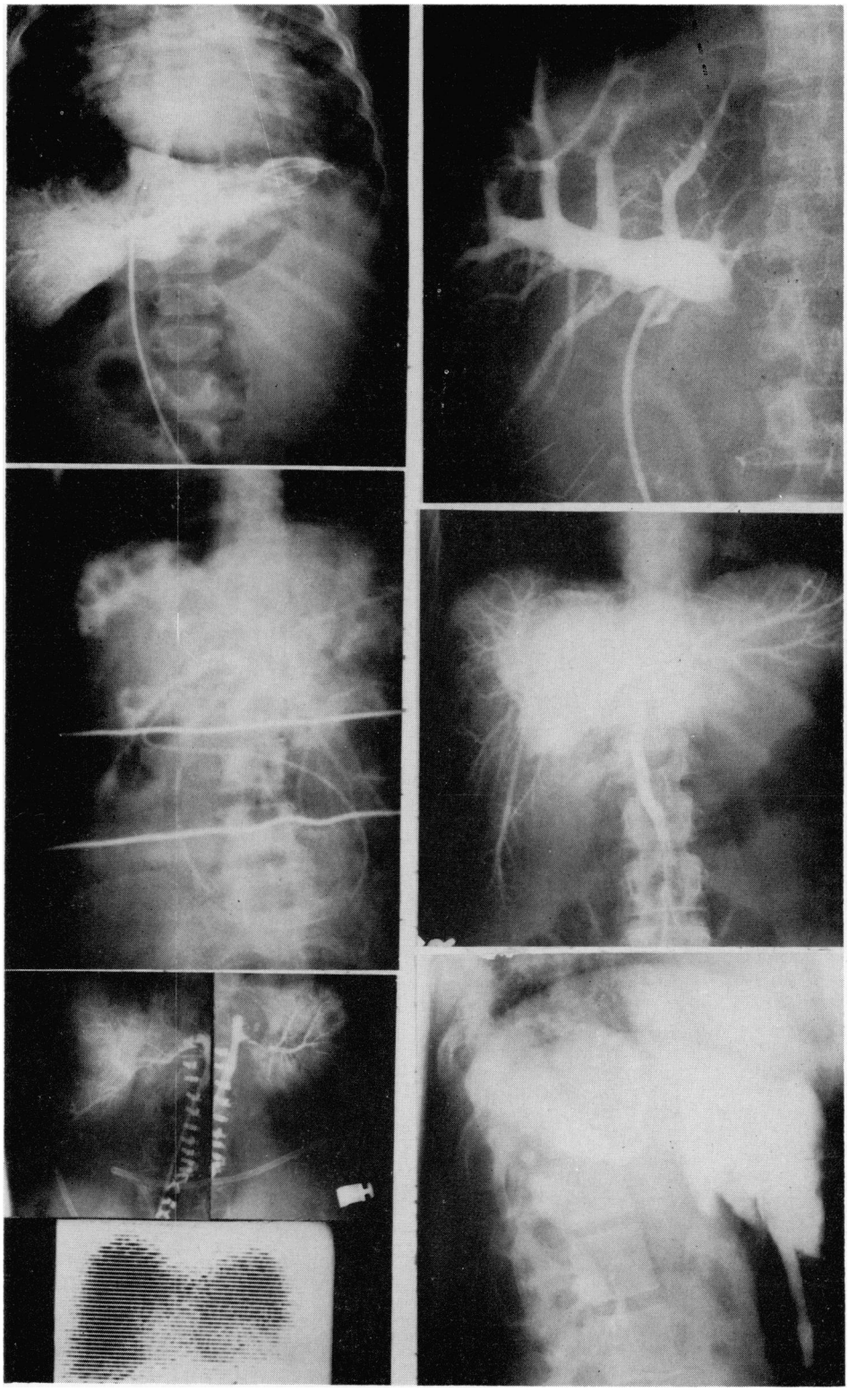


Fig. 7. Case 93673, Prince George's Hospital. This postshunt double-barreled anastomosis reveals a large vein running toward the diaphragm from the liver. An end-to-side anastomosis would not have decompressed this large collateral vein.

Fig. 8. Case 103161, Washington Hospital Center. This 40-year-old white male had an end-to-side anastomosis. A large vein is running from the left (?) porta hepatis to the esophageal veins. This vein may have been better decompressed by a side-to-side anastomosis. He died two years later of recurrent hemorrhage.

Figs. 9 and 10. M. D. Case 116533, Washington Hospital Center. A 33-year-old female with cirrhosis of the liver. Drinking 19 years. Side-to-side anastomosis May 31, 1963. Postoperative portogram June 3, 1963. This postshunt side-to-side anastomosis is projected in anterior-posterior and lateral views to demonstrate the patency of the anastomosis.



Figs. 11, 12, 13, 14, 15 and 16—legends on page 274.

the acute variceal bleeder or chronic portal hypertensive patient. This portal vein study with pressure readings might be done in the cirrhotic patient who refused surgery, to determine the efficacy of surgical Pitressin and patency of the portal vein in case he should return with recurrent severe bleeding.

Space occupying lesions of the liver can be demonstrated, Fig. 12. The normal contour of the vascular pattern is missing and "voids" in the liver are seen. The portal vein is displaced medially in livers enlarged with metastases. Because of this vascular deficiency it is unlikely that chemotherapy via this route would be successful.

This procedure should be used when there is clinical reason to doubt a liver scan. These liver scans have been reported both falsely positive and falsely negative. A false positive scan is demonstrated in Fig. 13. This jaundiced patient had an obstruction at the lower end of the common duct secondary to a prior sphincterotomy six years ago. Hepatogram shows no metastases.

Persistent defects in the branch of the porta hepatis is seen in Fig. 14. This is one of the x-rays of the serial portohepatogram taken. Compared to the scan it is more diagnostic. There is no filling of the left porta hepatis and this is possibly due to thrombosis by neoplasm.

The umbilical vein hepatogram is available in all hospitals. It does not require specially trained people or a license to use radioisotopes. There are many "bugs" to be worked out in the liver scans, and they can be expensive.

This procedure may be quickly executed while intra-abdominal if a suspicion of an intrahepatic space-occupying lesion is present. The lesion may be better localized by use of a lateral projection during the injection. This study may be more helpful in cysts or abscess cavities of the liver.

Parahepatic lesions may be shown to be independent of the liver. A calcified cyst of the adrenal gland is shown Fig. 15 to be separate from the liver and above the kidney. Until the lateral projection was performed, a calcified cyst of the liver was suspected. In the surgical drainage of a subdiaphragmatic abscess, this may help in localizing the abscess.

This method of study permits the free aspiration of blood and monitoring of the portal pressure

Fig. 11. Case 33988, Providence Hospital. A 3-year-old female was admitted at the age of 18 months with abdominal pain, undiagnosed; secondary iron deficiency anemia that responded to iron therapy. Had inguinal herniorrhaphy at which time ascites were present. Returned at age 3 with asymptomatic splenomegaly. Portogram revealed vascular pattern of a normal liver. Portal pressure 24 cm. No filling of the portal vein is observed. No collaterals are present. This may be an extrahepatic block.

Fig. 12. Case 070095, Washington Hospital Center. 47-year-old female. Admitted with a traumatic ruptured spleen. Liver found filled with metastases. Intra-abdominal umbilical hepatogram reveals large "voids" in liver substance, diminution of number and size of vascular tree.

Fig. 13. Case 48712, Providence Hospital. 72-year-old female. Admitted with obstructive jaundice. Had sphincterotomy 5 years prior. Scan demonstrated 2 large lesions. These were not confirmed by umbilical vein hepatography. Had complete obstruction at ampulla with no liver metastases.

Fig. 14. Washington Hospital Center. 51-year-old male. This is one of a series taken on a rapid changer. Note the defect in the large branch that was constant. The left porta hepatis did not fill, probably due to thrombosis with tumor. It appears more conclusive in diagnosis than did the scan.

Figs. 15 and 16. Case 14300, Washington Hospital Center. 32-year-old female. This large calcified cyst was thought to be a part of the liver until a lateral projection during injection showed it to be an extra hepatic.

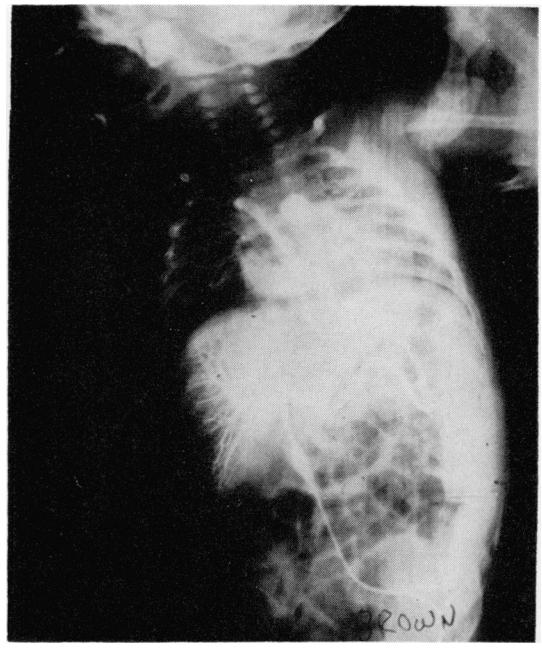


Fig. 17. Case 55534, Prince George's Hospital. 2 month old male. This infant admitted with severe diarrhea and vomiting, and on inspissated bile syndrome. The umbilical vein was used to hydrate the patient. An incidental hepatogram (8cc of 40% Hypaque) revealed the patency of the ductus venosus showing pulmonary artery and vena cava. The catheter was utilized to give intravenous fluids and determine blood chemistry for 8 days (patient of Dr. William Holbrook—personal communication).

during research. This may be done over many days by keeping the catheter open with a slow intravenous drip. It is an excellent way of giving intravenous fluids over many days in the postoperative period to obviate thromboses. In the newborn it can be useful to give fluids and monitor the central venous pressure in shocking procedures. It can be used in infants to visualize the right side of the heart (Fig. 17.)

SUMMARY

The umbilical vein approach to the study of the portal vein, its pressure, outline and blood constituents is presented. The contour and space-occupying lesions of the liver may be outlined. Its value in certain clinical conditions has been suggested. The research potential of this method is great. It may be done extraperitoneally under local anesthesia or utilized during an intra-abdominal procedure. There is no mortality and negligible morbidity with the procedure.

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(*Contents concluded*)