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Angiography in the Diagnosis and Therapy of Bleeding from Gastroesophageal Varices[1,2]

JOSEF RÖSCH AND CHARLES T. DOTTER

University of Oregon Health Sciences Center, Department of Diagnostic Radiology, Portland, Oregon 97201

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Angiography, with its various techniques of catheterization and visualization of visceral vessels, is assuming an increasingly important role in both the diagnosis and treatment of bleeding from gastroesophageal varices. In the acute stage of bleeding, emergency arteriography has helped visualize gastroesophageal varices and, occasionally, the actual bleeding as an extravasation of contrast medium into the gut. It has also aided in the diagnosis of variceal bleeding by excluding arterial bleeding, delineating the type of portal obstruction, differentiating extrahepatic from intrahepatic portal blocks,and shedding light on the type and stage of the basic hepatic disease. Angiographic and manometric studies of the hepatic veins have been used to assess functional changes in the portal circulation, thereby providing information pertinent to therapeutic decisions, particularly in indicating the need for surgery and in selecting the appropriate procedure. In a more direct therapeutic role, the selective infusion of vasopressin into the superior mesenteric artery is now one of the means for controlling variceal bleeding, particularly successful in patients without advanced liver disease. Recently, several techniques for catheterizing the portal vein have been used to block or restrict variceal bleeding by catheter tamponade or the injection of occlusive material. In this report we will summarize our clinical and animal experience in the use of angiographic technique for the diagnosis and treatment of gastroesophageal variceal bleeding and discuss some other promising therapeutic catheter techniques. Although some of these techniques may sound like science fiction, they are practical procedures in the laboratory and may be of clinical use in the near future.

ANGIOGRAPHIC DIAGNOSIS OF VARICEAL BLEEDING

In *acute gastroesophageal variceal bleeding,* visceral arteriography is the angiographic procedure of choice (1–3). We consider it complementary to endoscopy and use it in cases where endoscopy cannot be done or fails to differentiate between variceal and arterial bleeding. A complete arteriographic examination includes selective celiac, left gastric, and hepatic or gastroduodenal studies plus superior mesenteric pharmacoangiography. How much of the foregoing is done depends upon the patient's condition and the information sought. Selective celiac and hepatic arteriograms help assess the type and stage of hepatic disease, particularly in differentiating hepatitis and cirrhosis from hepatic malignancies, and in evaluating

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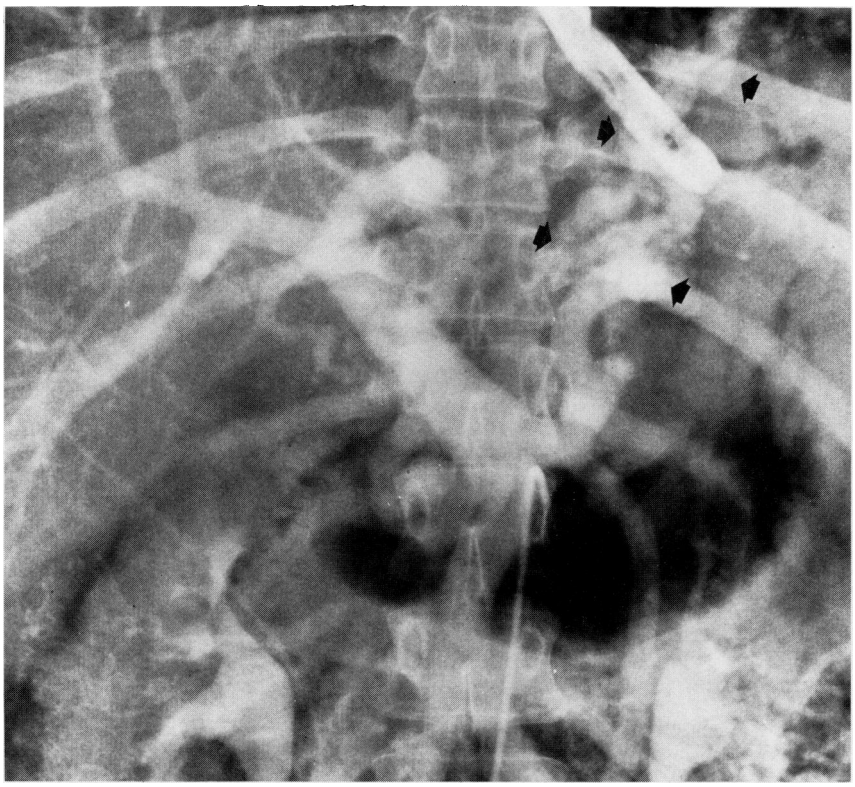


FIG. 1. A 42-year-old female with advanced cirrhosis and massive bleeding from gastroesophageal varices. Venous phase of the superior mesenteric pharmacoarteriogram after the injection of tolazoline shows an intrahepatic portal block with multiple hepatofugal collaterals, including large coronary vein and gastric varices (arrows).

the stage of cirrhosis and the degree of liver "arteriolarization" and regeneration (4, 5). A superior mesenteric pharmacoarteriogram after the injection of tolazoline improves visualization of the portal circulation, thereby aiding in differentiating intrahepatic (Fig. 1) from extrahepatic block (Fig. 2), in delineating collateral circulation, including varices, and in assessing portal flow (6). The prolonged injection of contrast medium into the left gastric artery can show varices when other methods fail (7) (Fig. 3). In suspected variceal bleeding, the selective left gastric and gastroduodenal or common hepatic arteriograms are used to rule out arterial sources of gastroduodenal bleeding. Unless endoscopy has been able to show the site of bleeding, this question should be approached arteriographically, since, in approximately 40% of cirrhotics with varices, acute bleeding will come from an arterial source such as erosive gastritis, a peptic ulcer, or a Mallory–Weiss tear and not from the varices (8–10). Bleeding due to gastritis is characteristically multifocal, and its arteriographic visualization usually requires direct injection into the left gastric artery. Ordinarily, we do not expect or try to show direct intraluminal extravasation of contrast medium from a bleeding varix. This is a relatively rare finding, difficult to differentiate from superimposed filled varices. The arteriographic diagnosis of variceal bleeding is thus indirect, being based on the presence of known upper GI bleeding, the visualization of varices, and the nonvisualization of arterial bleeding (1–3) (Figs. 1–3).

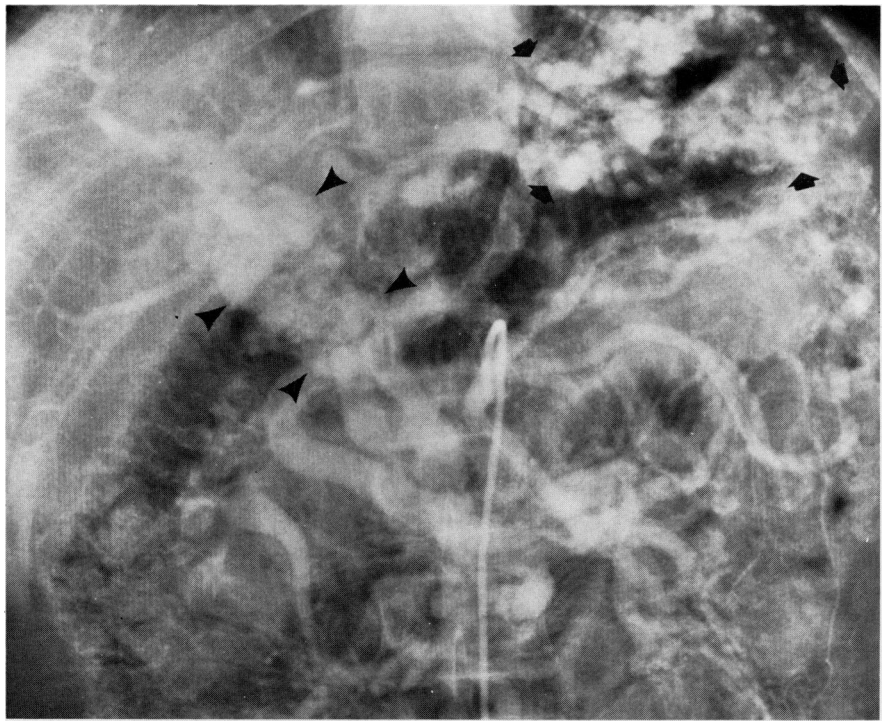


FIG. 2. A 17-year-old man with "cavernomatous transformation" of the portal vein and massive bleeding from gastroesophageal varices. Venous phase of the superior mesenteric pharmacoarteriogram after the injection of tolazoline shows an extrahepatic portal block with multiple hepatopetal and hepatofugal collaterals. The hepatopetal collaterals in the area of the occluded portal vein form an irregular "cavernomatous" network (arrowheads). The hepatofugal collaterals include large gastric varices (arrows).

Visceral arteriography usually gives the needed information in acute variceal bleeding. We have had little diagnostic use for transplenic, transhepatic, or transumbilical portography. The latter two methods, however, are of considerable potential value in the nonsurgical catheter treatment of variceal bleeding.

ANGIOGRAPHIC EVALUATION FOR PORTOSYSTEMIC SHUNT SURGERY

Following an episode of gastroesophageal variceal bleeding, angiography including arteriographic, venographic, and manometric studies is used for a detailed evaluation in preparation for possible shunt surgery (4, 11). Such an arteriographic examination includes selective celiac and hepatic arteriography and superior mesenteric pharmacoarteriography done with the above-mentioned objective. A selective splenic angiogram is often done to visualize the splenic vein when a splenorenal shunt is under consideration. Manometric studies in the hepatic veins (both free and wedged positions), right atrium, and inferior vena cava help to assess the degree of portal hypertension and exclude constriction of the inferior vena cava by a cirrhotic liver (4, 11). Both free and wedged hepatic venograms aid in evaluating the degree of cirrhosis and portal flow patterns, information essential to the proper selection of a shunt procedure (11–13) (Fig. 4). Where there is a pressure gradient between right atrium and the subhepatic inferior vena cava, an inferior cava venogram is also done to show

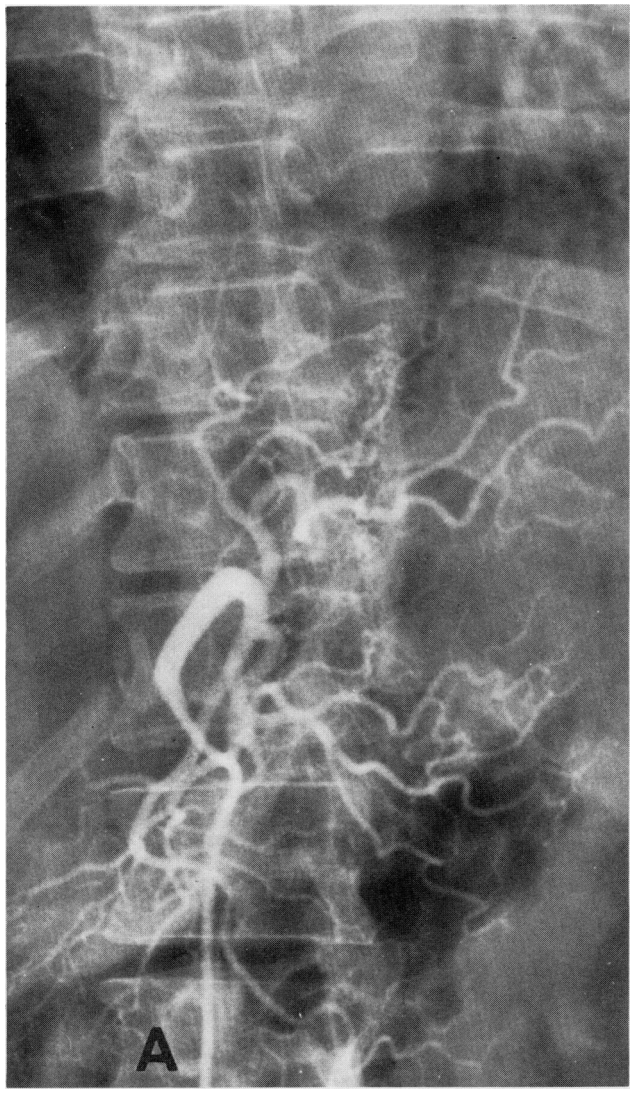
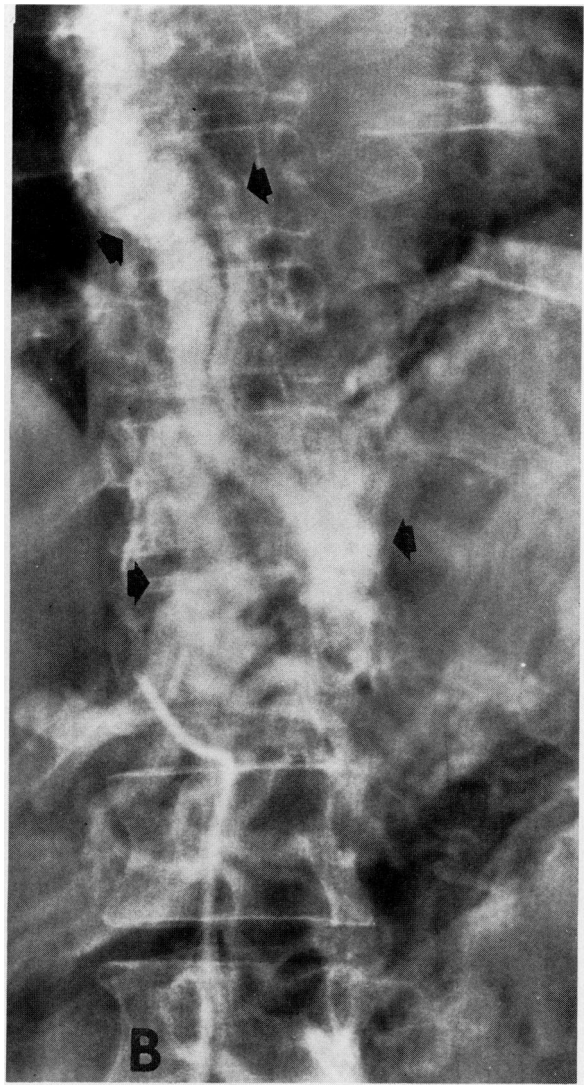


FIG. 3. A 58-year-old man with advanced cirrhosis and gastroesophageal variceal bleeding. Selective left gastric arteriogram with prolonged (8 sec) injection of contrast medium. (A) Arterial phase reveals

the type and degree of stenosis. The left renal vein is visualized prior to planned splenorenal shunting. Splenoportography by direct transparietal puncture with measurement of splenic pressure is occasionally used preoperatively, particularly if selective splenic arteriography has failed to visualize the splenic vein (14). Intrasplenic pressure measurements are used to assess portal hypertension in patients with intrahepatic presinusoidal block, a situation where the wedged hepatic vein pressure is not an adequate indicator of portal pressure (4, 11).

Following portosystemic shunt surgery, angiography can give information concerning shunt patency, as well as changes in portal pressure and gastroesophageal varices. In portocaval or conventional splenorenal shunts, either superior mesenteric pharmacoangiography (with preinjected tolazoline) or direct catheterization of the shunt via the inferior vena cava can show the shunt and residual varices (15, 16). In



increased size of gastric arteries. (B) Venous phase demonstrates large varices in the upper part of stomach and lower portion of esophagus (arrows).

distal splenorenal shunts, direct shunt catheterization is often necessary for adequate shunt visualization (Fig. 5). Postoperative changes in portal pressure and flow patterns can also be assessed by free and wedged hepatic vein manometry and venography (17).

CATHETER THERAPY IN VARICEAL BLEEDING

Selective intraarterial vasopressin infusion into the superior mesenteric artery, introduced in 1967, is a relatively widely used modality for controlling massive variceal bleeding (18–20). We and others have not achieved therapeutic results as good as those in the initial report (21–24). Of 38 treated patients, we achieved complete control without immediate recurrence in 24 patients (63%), limited control with temporary cessation of bleeding in 5 patients, (13%), and no control in 9 patients (24%).

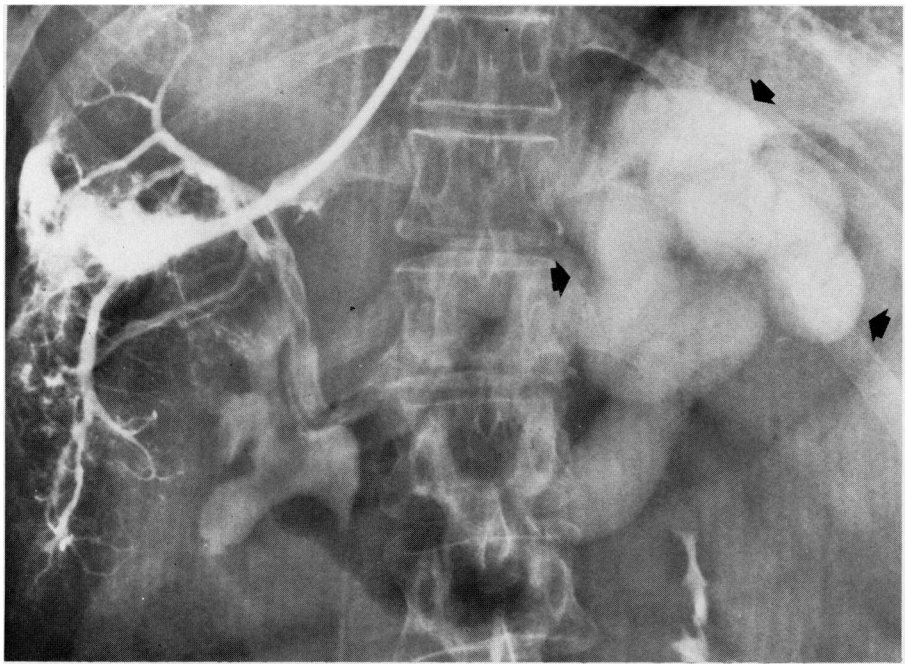


FIG. 4. A 62-year-old female with advanced cirrhosis and bleeding from gastroesophageal varices. Wedged hepatic venogram demonstrates reversal of flow in the portal system with retrograde filling of the portal vein, enlarged coronary vein, and multiple large gastric varices (arrows).

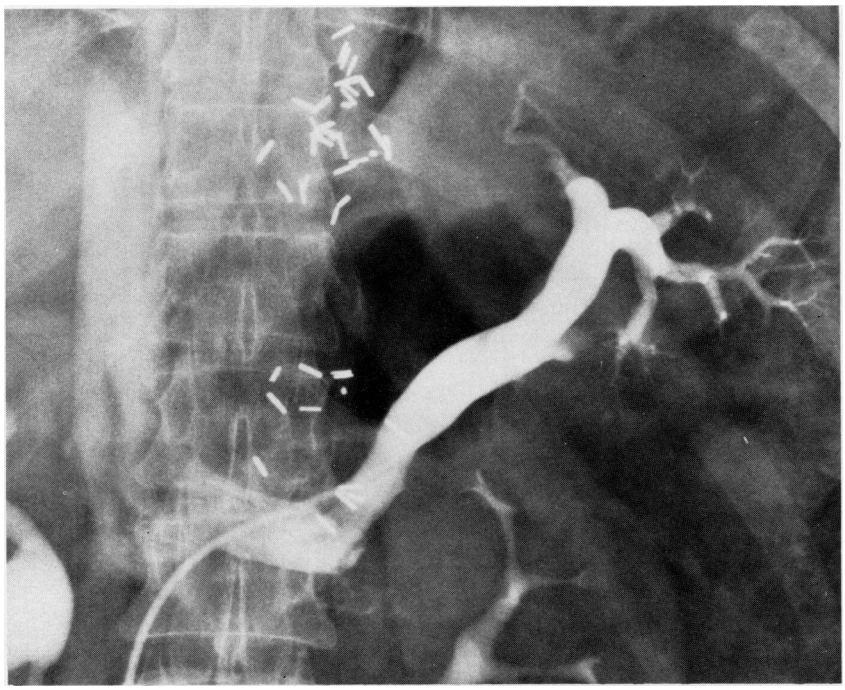


FIG. 5. A 47-year-old man with a distal splenorenal shunt. Selective catheterization of the shunt and injection of contrast medium into the splenic vein demonstrate good patency and function of the shunt with filling of the left renal vein and inferior vena cava.

Case selection undoubtedly influenced the varied results reported by different workers. While patients with mild or moderate liver damage usually respond readily to vasopressin infusions, this form of therapy is unreliable in patients with advanced cirrhosis, liver failure, and faulty coagulation. We have had no major complication in our series such as bowel ischemia or embolization (24). In one of our patients, femoral artery puncture site spasm necessitated unintended catheter removal, and in two patients septicemia developed but cleared after catheter removal.

Low dose continous intravenous vasopressin infusion in amounts corresponding to those used intraarterially (0.2 to 0.3 U/min) has in our practice virtually replaced selective intraarterial infusions. In animal experiments comparing selective intraarterial and intravenous vasopressin infusions, we have found no statistical differences in their effects on portal flow, portal and systemic blood pressure, and cardiac output (25). Furthermore, we found that small amounts of vasopressin given intravenously gave relatively high splanchnic and low systemic effects, compared to those of larger doses used previously for a "bolus" injection (20 U in 5 to 20 min) (25). An attempted controlled clinical comparison of selective superior mesenteric and low dose intravenous vasopressin treatment was never completed, since the latter technique seemed far preferable. Pragmatism prevailed over science, as often happens in an emergency situation, and all our variceal bleeders are now given low dose intravenous vasopressin infusions, with or without esophageal balloon tamponade. Of 28 patients managed this way, bleeding stopped in 22 (79%). Selective mesenteric arterial vasopressin was then given to the six patients where intravenous infusions failed, and it succeeded in two, both in association with esophageal balloon tamponade. A beneficial effect of continuous intravenous infusions of vasopressin was also reported by others (26). Using a higher dose of vasopressin (0.66 U/min), they combined it with infusion of isoproterenol (0.002 mg/min) to decrease its adverse systemic effects (27). Despite these favorable experiences with continuous intravenous infusions, however, only a controlled study can provide the needed objective comparison of the various routes of vasopressin administration.

Intravascular tamponade of the gastric coronary vein and varices is a new and highly experimental method of catheter therapy for bleeding from gastroesophageal varices (28–32). It involves direct catheterization of the portal circulation, which can be done via the umbilical vein or liver puncture by a transperitoneal or transvenous approach. We prefer the transvenous approach, in which a catheter needle system is introduced percutaneously into the internal jugular vein and advanced through the right atrium into a hepatic vein, from which site the needle punctures the liver and enters a major intrahepatic portal branch. The catheter follows the needle and is advanced into the portal vein (Fig. 6A). We routinely use this transvenous approach for transhepatic cholangiography and occasionally for liver biopsy (33). Since transperitoneal passage and puncture of the liver capsule are not involved, transvenous portal catheterization can be done even in patients with hemocoagulation defects, ascites, and high grade jaundice, without risk of hemoperitoneum or bile peritonitis. A large-diameter catheter can also be introduced into the portal vein, enabling the coaxial placement of a smaller catheter, permitting easy catheter exchange and favoring selective catheterization for embolization of multiple target veins and varices (31, 32, 34) (Fig. 6B). The possibility of creating a transhepatic portosystemic fistula is another advantage of the transvenous approach (35).

For the intravascular tamponade of bleeding varices, a catheter is introduced into the gastric coronary vein. Temporary tamponade can be done by using a balloon catheter. For permanent blockage, injections of concentrated glucose, thrombin, au-

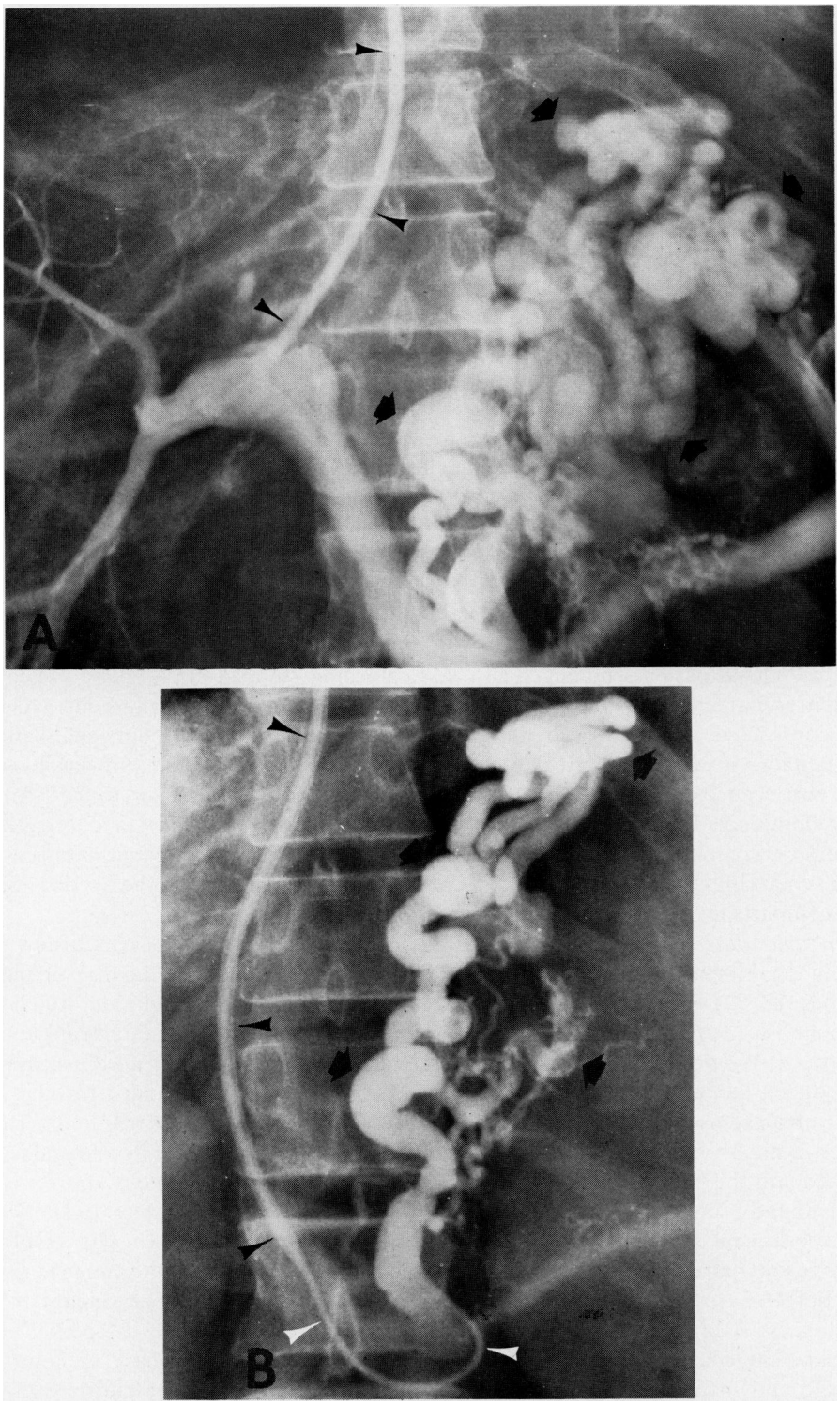


FIG. 6. A 53-year-old man with advanced cirrhosis and massive bleeding from gastroesophageal varices (courtesy of Dr. M. L. Goldman). (A) Retrograde portal venogram done via the transjugular approach shows large gastric varices (arrows; black arrowheads indicate the transjugularly introduced catheter). (B) Selective venogram of the gastric coronary vein and gastric varices (arrows) via a small catheter (white arrowheads) coaxially introduced through the large transjugular catheter (black arrowheads).

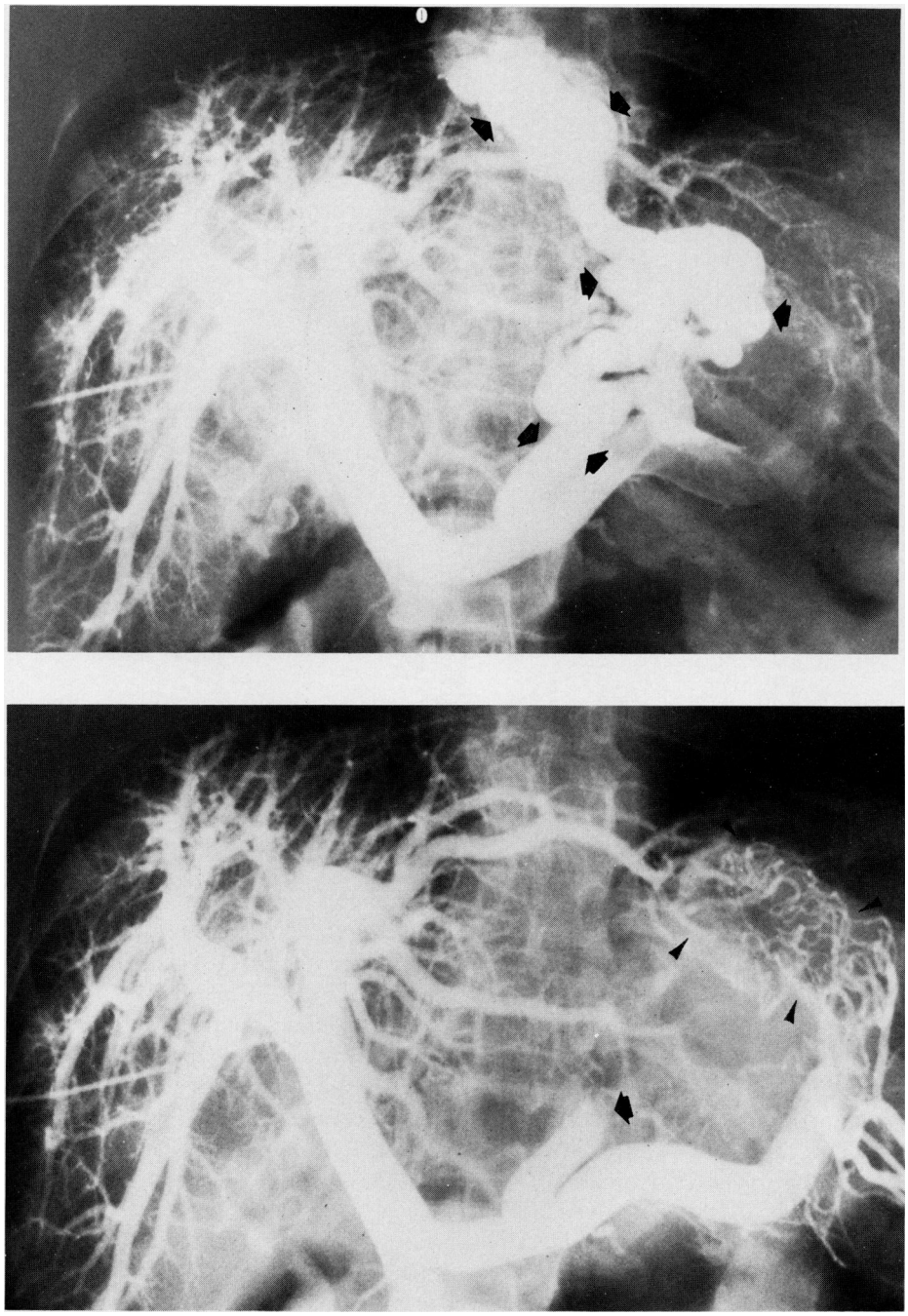


FIG. 7. Intravascular tamponade of the gastric coronary vein and gastroesophageal varices in a 48-year-old man with cirrhosis and acute GI bleeding (courtesy of Dr. A. Lunderquist). (A) Control retrograde portogram performed by the transperitoneal route visualizes the large gastric coronary vein and gastroesophageal varices (arrows). (B) Follow-up retrograde portogram about 1 hr after injection of isobutyl-2-cyanoacrylate selectively into the distal part of the gastric coronary vein shows occlusion of this vein (arrow) with no more filling of gastroesophageal varices. There is reflux of contrast medium into the superior mesenteric and particularly into the splenic vein with retrograde filling of slightly enlarged short gastric veins (arrowheads).

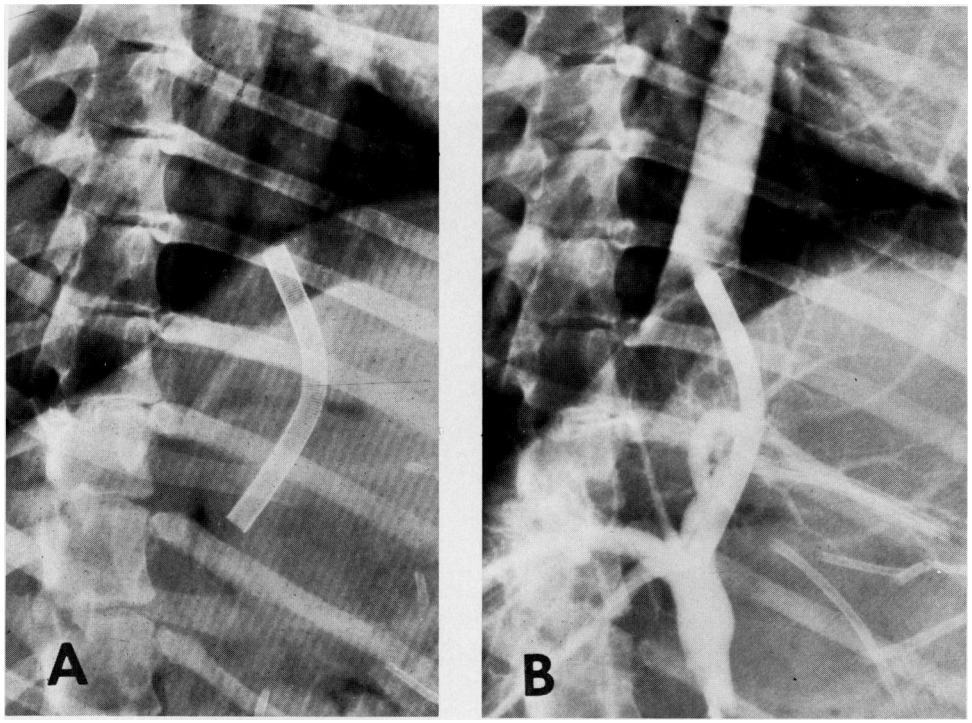
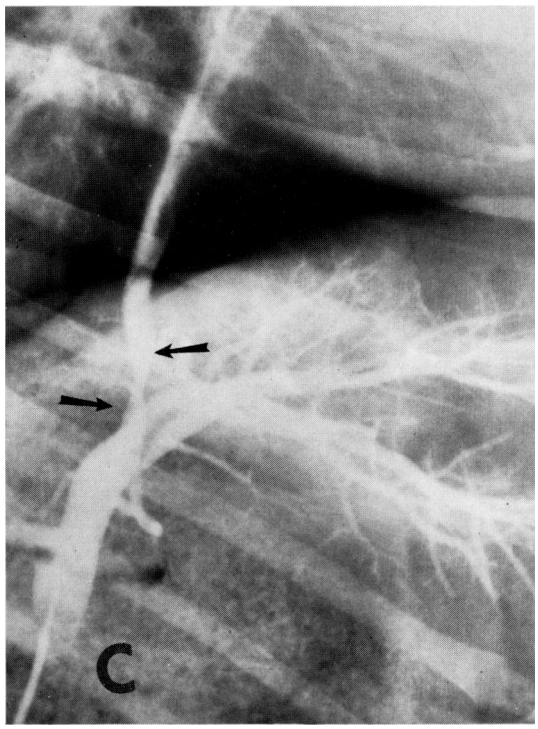


FIG. 8. Experimental intrahepatic portosystemic shunt and fistula in a dog, achieved by transjugular approach. (A) Plain film of a spring coil tubing placed into the liver via a transjugular catheter. (B) Portal venogram 3 days after spring coil tubing placement performed via a mesenteric vein catheter demonstrates shunting of a part of the portal blood into the systemic circulation with filling of the inferior

tologous clots, or gelfoam reportedly have been used clinically to embolize varices and occlude the coronary vein (28–30, 32). In animals we have used a rapidly polymerizing liquid tissue adhesive, isobutyl-2-cyanoacrylate, to produce selective long-segment "cast" tamponade of the gastric and splenic veins (31). This tissue adhesive has also been used with good success in patients (36) (Figs. 7A and B).

Clinically, tamponade of the coronary vein is expected to have only a temporary effect. Multiple branches of the splenic and portal veins supplying varices must be occluded for more adequate control over bleeding. Sudden tamponade of varices carrying a large portal runoff is certain to cause an increase in portal hypertension until new collateral routes develop, ideally not in the esophageal and gastric wall. A combination of variceal tamponade with the creation of an intrahepatic portosystemic fistula could be used to avoid a sudden increase in portal hypertension.

Intrahepatic portosystemic shunts have been successfully achieved by us in dogs (35). Using the transjugular approach, with liver puncture and entry into the portal circulation, the puncture tract in the liver was dilated to a diameter of 6 mm by a system of coaxial dilating catheters. A short length of tubing slipped over the catheters was then left in place in the liver, forming a graft between the portal vein and the inferior vena cava (Fig. 8A). Such shunts have stayed open in normal dogs without portal hypertension for 6 to 12 days (Fig. 8B). After percutaneous retrieval of shunt tubes left in place for less than 5 days, the fistulous tracts closed rapidly. When shunt tubes were left in place for 2 weeks, portocaval fistulas persisted for 24 to 48 hr (35) (Fig. 8C).



vena cava. (C) Close-up view of the portal venogram performed via a mesenteric vein catheter 24 hr after retrieval of the spring coil tubing, which was left in place for 14 days. There is an intrahepatic portosystemic fistula in the place of the retrieved tubing (arrows).

In patients with cirrhosis and portal hypertension, it is possible that simple dilatation of a portovenous transhepatic puncture tract may create a permanently patent fistula. In combination, the abnormally rigid cirrhotic hepatic parenchyma and portal hypertension with high flow through the fistula would favor patency, particularly when a sudden increase of portal pressure followed intravascular tamponade. We hope this will some day provide means not only for management of acute variceal bleeding but also for the nonsurgical relief of portal hypertension. Although unconventional, it is a rational approach with a reasonable chance of success in an area where progress is much needed.

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