

# Clinical Experience with the Diagnosis and Management of Gastrointestinal Hemorrhage by Selective Mesenteric Catheterization

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SEVEN years experience with selective mesenteric arteriography in more than 1,000 patients who were studied for gastrointestinal diseases has established this technic to be readily accessible and safe in our institution. A major interest has been the preoperative demonstration of sites of gastrointestinal bleeding by selective mesenteric arteriography. The efficacy of this technic was originally worked out in experimental animals in whom bleeding points in various gastrointestinal sites were artificially constructed at laparotomy and rates of bleeding as low as  $\frac{1}{2}$  cc. per min. were demonstrated by selective arteriography.<sup>12</sup>

The initial clinical study was applied only to patients with massive upper gastrointestinal bleeding who were on their way to emergency surgery.<sup>13</sup> Thus this became a preoperative study which was accomplished in the Special Studies Division of the Department of Radiology while blood was being transfused and the operating room was readied for emergency surgery. Our success in demonstrating the

site of hemorrhage in this group encouraged us to extend our indications to include actively bleeding patients, even though emergency surgery was not contemplated. In addition, we included a third group of patients who were not actively bleeding, but had previous recurrences of hemorrhage for which no cause was found by conventional barium studies and endoscopy.

A wide variety of bleeding lesions have been demonstrated including: Mallory-Weiss tears of the gastroesophageal junction, gastric and duodenal ulcers, gastric and duodenal erosions, tumors, diverticular bleeding of the colon, postoperative stress ulcers and arteriovenous malformations.<sup>3</sup> Recent development of a serial magnification technic during selective mesenteric arteriography which utilized a 0.3 mm. focal spot has resulted in the diagnosis of occult bleeding of the gastrointestinal tract secondary to a variety of vascular ectasias. This technic will define vessels in the range of 50 to 90 microns.<sup>4</sup>

These mesenteric catheters have been used for therapeutic infusions in selected bleeding patients.<sup>15</sup> Small pharmacologic dosages of surgical Pituitrin have been infused directly into the superior mesenteric artery to control massive hemorrhage from gastroesophageal varices. They have been used in cirrhotic patients with portal hypertension and in patients with gastrointestinal bleeding from other causes such as

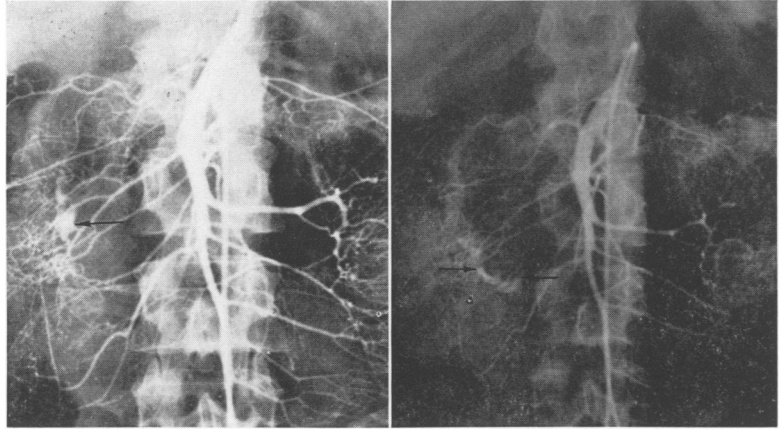
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FIG. 1. Bleeding post-operative stress ulcer. This patient developed massive upper gastrointestinal hemorrhage 1 week following aortic valve replacement. After unremitting bleeding requiring 18 units of blood replacement, selective mesenteric arteriogram was performed. A. (left) One half second after injection of contrast into the superior mesenteric artery early accumulation of extravascular contrast is seen (arrow). B. (right) One second after, mucosal folds are recognized (arrow).



recurrent bleeding gastric ulcers, bleeding hepatomas, and bleeding gastroduodenal arteries.

### Results

One hundred patients have been studied for either acute or occult bleeding from the gastrointestinal tract. Sixty patients were studied with massive hemorrhage from the upper or lower gastrointestinal tract. In 45 of these patients, selective mesenteric arteriography has been successful in localizing the site of hemorrhage. Forty additional patients were studied for histories of previous massive hemorrhage or for occult bleeding at the time of the study. Twelve of these patients were found to have a variety of vascular ectasias or arteriovenous malformations which were presumed to be the site of hemorrhage. It is in this group that direct serial magnification arteriography was most helpful in eliciting the source of bleeding. In an additional 15 patients, indirect evidence of the site of hemorrhage was elicited by mesenteric arteriograms which satisfied the authors of the origin of the bleeding episodes. Thus, in 72 out of 100 patients, either direct or indirect indication of the source of gastrointestinal hemorrhage was obtained.

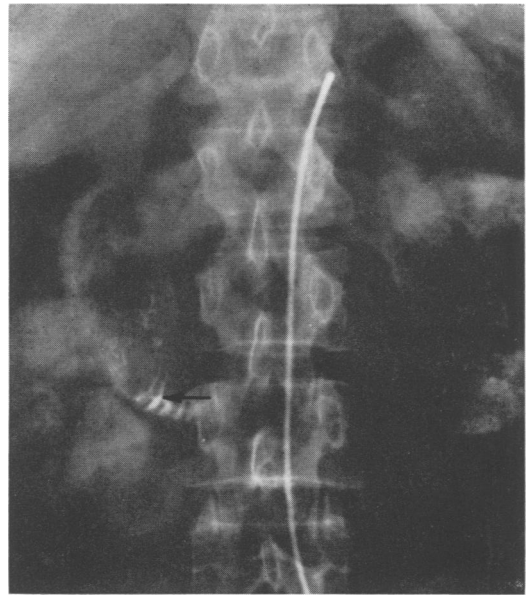


FIG. 1C. Ten seconds after injection, extravascular contrast remains outlining mucosal folds at junction of second and third portions of the duodenum (arrow). Immediate surgical exploration confirmed the arteriographic location of a stress ulcer of the duodenum which was oversewn. A vagotomy and pyloroplasty was done with complete recovery of the patient.

Direct infusion of surgical Pituitrin into the mesenteric circulation has been utilized in the management of eight patients to date. In five instances, Pituitrin was infused into the superior mesenteric arteries in an attempt to control hemorrhage from

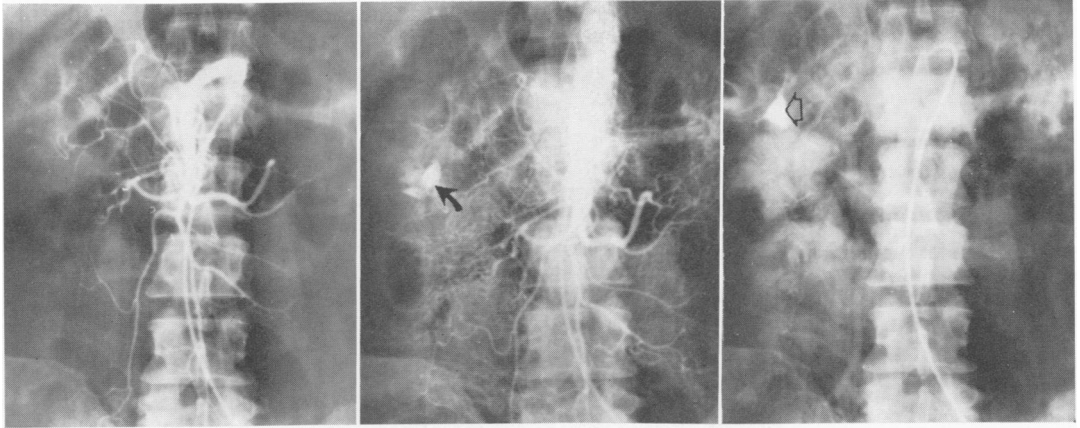


FIG. 2. Bleeding diverticulum of ascending colon. This patient presented with massive colonic bleeding. Shortly following admission a mesenteric arteriogram was performed. A. (left) One half second after injection of contrast into the superior mesenteric artery there is early incomplete filling of major branches. B. (center) After 2 seconds contrast material is seen to extravasate from a branch of right colic artery (arrow). C. (right) Fifteen seconds after injection contrast material persist in diverticulum (arrow). At surgery the ascending colon was resected and the bleeding diverticulum confirmed pathologically.

bleeding varices in portal hypertensive and cirrhotic patients. In four patients, complete cessation of gastrointestinal bleeding was achieved during the course of the infusions. Two patients underwent semiselective portacaval shunts after 5 days of stabilization by superior mesenteric infusion of surgical Pituitrin. Both patients showed marked improvement of hepatic and cerebral function during drug infusion and it was believed that they underwent the shunt procedures under optimum conditions. Infusion of the surgical Pituitrin which was continued during the procedure, resulted in complete collapse of the collateral circulation, significantly decreased blood loss during operation and facilitated exposure of the portal vein.

The third patient was maintained for 2 weeks by intermittent infusion of Pituitrin until bleeding from varices was controlled. This patient could not undergo shunt procedure due to congenital malformation of the portal and superior mesenteric veins and loss of the splenic vein during childhood. He succumbed approximately 6

months later of acute myocardial infarction without rebleeding. The fourth patient was successfully managed over a 2-week period by intermittent infusion of surgical Pituitrin for the control of variceal hemorrhage; however, the patient with portal vein thrombosis, massive ascites, hepatic encephalopathy and coma failed to respond sufficiently to allow surgical intervention for shunting. She died in hepatic coma approximately 3 weeks after admission.

The mesenteric circulation of the fifth patient failed to respond to the infusion of surgical Pituitrin. Infusing angiotensin into the superior mesenteric artery also failed to demonstrate any contractility of the mesenteric circulation. This patient's hemorrhage was controlled by balloon tamponade until an urgent portacaval shunt could be performed. The patient died 3 weeks later of progressive liver failure. It is believed that this patient with major hemorrhage and shock failed to react to pressor agents probably because of circulating vasoactive substances such as

FIG. 3. Arteriovenous malformation of cecum. This patient presented with 20-year history of recurrent melena and negative barium studies and surgical exploration. A. (left) Conventional superior mesenteric arteriogram in late arterial phase suggest a possible vascular malformation in cecum (arrow). B. (right) Direct serial magnification arteriogram in late arterial phase demonstrates arteriovenous malformation with early anomalous venous return (arrow).



histamine and possibly bradykinin at the time of infusion.

Three additional patients were selectively infused with surgical Pituitrin to control a variety of arterial hemorrhage. One patient with a massive hepatoma that had ruptured causing hemoperitoneum was successfully controlled by selective infusion of Pituitrin into the hepatic artery for 72 hours; however, due to the extensive nature of the tumor, no surgical intervention was attempted and the patient died. The second patient underwent pancreatoduodenal resection and developed massive upper gastrointestinal hemorrhage 9 days postoperatively. Conventional arteriography failed to reveal the source of bleeding; however, following infusion of surgical Pituitrin into the celiac axis, peripheral resistance in the hepatic radicles increased and massive hemorrhage developed from the side of the right hepatic artery which originated from the gastroduodenum. The Pituitrin, in this instance, helped to identify the site of bleeding although it did not control its rate; if anything, it increased the rate of hemorrhage in this particular patient.

The third patient was a man with extensive hemorrhagic pancreatitis who developed massive upper gastrointestinal bleeding from a lesser curvature gastric ulcer. At laparotomy, gastric resection was im-

possible as was vagotomy due to the size of the pancreas and local inflammation. The stomach was opened and the ulcer crater was sutured. Approximately one week postoperatively, massive upper gastrointestinal hemorrhage recurred. The site of bleeding was demonstrated by mesenteric arteriography to be in the area of the same gastric ulcer. A catheter was threaded into the left gastric artery and a selective infusion of surgical Pituitrin was begun. Utilizing the arteriogram taken during the infusion of Pituitrin, the dose was regulated to maintain adequate circulation to the remainder of the stomach. Rapid cessation of bleeding resulted. The infusion was carried on intermittently for the next 6 days until the patient's hemorrhage had completely stopped without further Pituitrin infusion. The patient rebled several days later and after repeat catheterization of the left gastric artery and infusion of surgical Pituitrin for 3 days hemorrhage ceased; this time, without further rebleeding. This patient recovered uneventfully.

Representative cases will be demonstrated in the ensuing illustrations (Fig. 1-5).

### Discussion

The diagnosis of the site of hemorrhage in the gastrointestinal tract has always

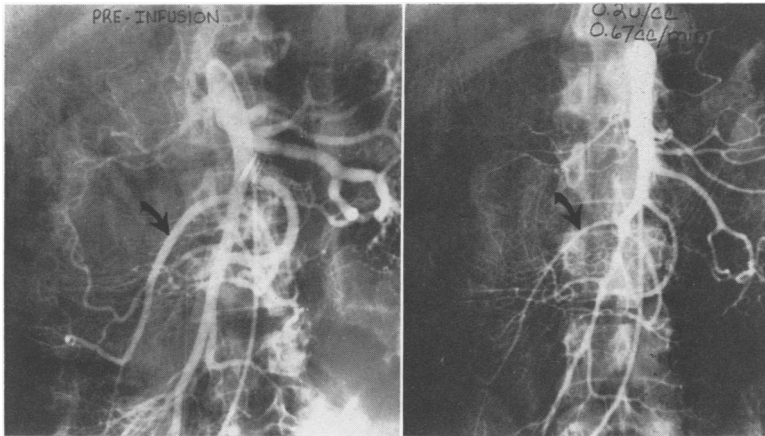


FIG. 4. Selective mesenteric infusion of Pituitrin to control bleeding esophageal varices. A. (left) Pre-infusion superior mesenteric arteriogram demonstrating normal filling of peripheral branches. B. (right) Superior mesenteric arteriogram after infusion of Pituitrin (0.2 units/cc. at rate of 0.67 cc./min.) for 15 minutes. Note the decrease in caliber of major arterial branches but persistence of distal flow. (Arrows point to right colic artery in each study for comparison of size.) This patient was con-

trolled by maintaining continuous infusion over 5 days until surgical portocaval demopression was accomplished.

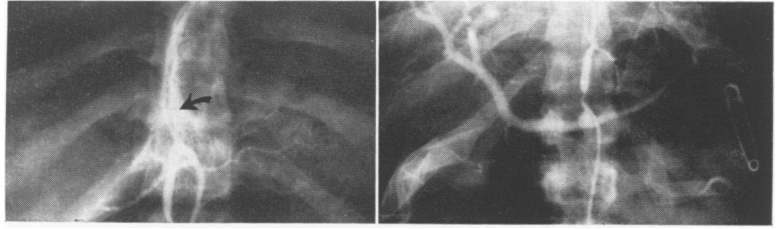
been a most difficult problem. The clinician utilizing the aid of conventional radiology and experienced endoscopy must frequently resort to exploratory laparotomy in an attempt to determine the site of bleeding.<sup>2, 6, 9</sup> Even after laparotomy, cause of bleeding goes unrecognized in as many as 20% of patients in upper gastrointestinal hemorrhage and some 70% of patients who undergo operation for colonic bleeding.<sup>16</sup> At laparotomy the stomach and gastrointestinal tract is often found full of blood with no external indications of the possible site of hemorrhage. This is even more of a problem in the colon where bleeding from any site may rapidly fill the colon with blood so that the site of hemorrhage cannot be visualized. In addition, at the time of surgery, very often the hemorrhage has temporarily subsided and the surgeon is only confused by the particular level of blood within the gastrointestinal tract that is observed.

Other technics to improve diagnostic acumen in the management of bleeding have led to less than optimum results. Utilization of fluorescein string tests and recovery of radioactive isotopes from the gastrointestinal tract have occasionally been used with success but have not been widely accepted. In 1960, Margulis *et al.* reported

successful use of operative segmental mesenteric arteriography for the demonstration of a bleeding cecal arteriovenous malformation.<sup>11</sup> In 1963, the authors reported the demonstration of artificially constructed bleeding points in dogs by means of percutaneous selective mesenteric arteriography utilizing the Seldinger technic.<sup>12</sup> Because of the ability to demonstrate bleeding rates as small as 0.5 ml. per min. by serial filming, this method was used clinically in selective patients.

Initial experience in patients was recorded in 1965<sup>13</sup> and subsequently re-evaluated in 1967.<sup>3</sup> Since that time, other investigators have successfully used this method.<sup>1, 5, 8, 10, 17</sup> Conventional selective arteriography of the celiac, superior mesenteric and inferior mesenteric arteries has demonstrated the ability to identify directly or indirectly the sites of bleeding of various portions of the gastrointestinal tract. During the past 2 years, a technic for magnification arteriography has been developed in our institution. Because x-rays are generated from a finite source, which in conventional x-ray tubes is 2 mm. in diameter, the subject must always be as close to the film as possible to decrease the geometric unsharpness which otherwise results. Recent advances in x-ray tube

FIG. 5. Bleeding gastric ulcer controlled by sub-selective infusion of Pituitrin into the left gastric artery. A. (left) Pre-infusion sub-selective left gastric angiogram demonstrates extravasation of contrast high on lesser curvature of stomach (arrow). B. (right)



Sub-selective left gastric angiogram following infusion of Pituitrin (0.2 units/cc./min.) for 15 minutes directly in the left gastric artery. Note the marked constriction of left gastric artery and its branches. Also note reflux filling of celiac axis due to increased peripheral resistance in left gastric artery.

design, which incorporate a high speed rotating anode to speeds of 10,000 r.p.m., have enabled the generation of a sufficient x-ray output from small focal spots for serial filming. When a fractional focal spot of 0.3 mm. in diameter is used, the patient can be placed midway between the focal spot and the x-ray tube so that magnification of approximately 2 times linear or four fold in area is obtained without loss of image sharpness. Adapted to the magnification tube, is an automatic serial film changer which allows exposures of up to ten films at one second intervals. This technic was applied in the laboratory with adequate definition of vessels in the range of 50 to 100 micra in diameter. With the use of magnification technic in patients with occult bleeding and intermittent massive bleeding, a variety of bleeding lesions have been uncovered including: arteriovenous malformations of the colon and small bowel, vascular tumors, and vascular malformations of the duodenum, stomach, and small intestine, post-traumatic erosions and fistulous granulation tracts in the colon.<sup>4</sup>

The control of portal hypertension and associated bleeding esophageal and gastric varices in emergency situations continues to be a major problem. Experience with tamponade and cooling have been less than ideal. Experience has been gained in the laboratory with the selective infusion of vaso-active substances directly into the superior mesenteric artery of dogs with ex-

perimental portal hypertension and has been reported in 1967.<sup>14</sup> It was found that the infusion of low dosages of surgical Pituitrin in the range of 0.2 of a surgical pressor unit per cc. per min. produced a decrease in 60% of the superior mesenteric artery flow and a concomitant decrease in portal pressure. It was also found that at this dose range there was no tachyphylaxis and there was no evidence of systemic hypertension or decrease in cardiac output. These technics were then applied in a series of clinical patients with massive variceal hemorrhage.<sup>15</sup> These patients are initially studied by conventional mesenteric arteriography in an attempt to discover the source of hemorrhage. The demonstration of cirrhosis on the hepatic arteriogram and the demonstration of portal hypertension and esophageal and gastric varices during the venous phase of the study as well as the failure to demonstrate a site of major arterial bleeding combined with the clinical history and physical findings, demonstrates the probability that bleeding is from the varices. Following this determination, the catheter is left in place in the superior mesenteric artery and infusion of small dosages of surgical Pituitrin are begun. An initial dose of 0.2 of a unit per cc. per minute is infused with the realization that circulating endogenous pressor and other vaso-active substances might materially change the reactivity of the mesenteric vasculature in a given patient at a given time. Infusions are administered

by a continuous infusion pump and after 10 to 15 minutes of infusion, a superior mesenteric arteriogram is again taken to demonstrate the effects of this concentration of drug on the superior mesenteric arterial vasculature. A good effect is demonstrated by the partial constriction of the major branches of the superior mesenteric artery with a decrease in wash-out time into the portal circulation. In the initial patients studied, a catheter was inserted into the umbilical vein to monitor portal pressure directly. We have found that this creates considerable amount of difficulty and appears unnecessary as long as one can monitor the dosage effect on the basis of serial mesenteric arteriograms. Once the reactivity of the superior mesenteric arterial tree to a given dose of drug is determined, it apparently does not change on subsequent examinations even several days apart. The average dosage utilized has been 0.2 of a pressor unit per cc. per minute although one patient required less than this and another patient required somewhat more than this. We are presently investigating the use of hepatic vein wedge pressures as a monitoring device in the management of these infusions. Following the determination of a satisfactory dosage schedule, the patient is removed to the intensive care area with the catheter in place and the infusion pump running. The infusion is continuously administered for the first 24 hours. If there is no evidence of continued bleeding, the infusion is maintained by infusing the maximum effective dosage for 30 minutes, alternating with an infusion of a minimal dosage for another 30 minutes. The infusions are continued anywhere from 5 days to 2 weeks until such time as the patient's liver functions return to a more normal state and the patient is considered an adequate risk for portacaval shunt. After experience in two patients, it is believed that it is advantageous to continue the infusions during

the operation so as to maintain decompression of the portal circulation at the time of surgery. This makes identification of the portal vein easier and decreases blood loss significantly. The infusion is stopped just prior to making the anastomosis so that sufficient pressure can be developed in the portal vein to allow for good flow at the time of the completion of the anastomosis. In patients with more elective portacaval shunts in whom active bleeding is not a problem, the superior mesenteric catheter has been inserted on the day of surgery and the infusion maintained during the operation in order to obtain the benefit of the decreased portal flow at the time of surgery. This appears to be a more ideal method of decreasing blood loss at surgery for portacaval decompression than hypothermia or hypotensive anesthesia, both of which decrease hepatic arterial blood flow which is so important to the cirrhotic liver. The patient should have the site of the catheter tip checked by fluoroscopy on daily or 48-hour intervals in order to be sure that the catheter has not been dislodged. It is also important to bypass the hepatic arterial circulation during the continuous infusion so as not to decrease the blood supply to the liver. One patient was found to have the hepatic artery arise from the superior mesenteric artery directly. In order to avoid perfusion of the liver, the catheter was advanced more distally into the mesenteric artery to bypass this branch. The dose of surgical Pituitrin infused was anticipated to have a maximal antidiuretic effect; however, in the patients studied, no decrease in urinary output was noticed, although fluid restriction was maintained in the cirrhotic patients who were hypervolemic to start with. We have had no complications at the catheter site from these infusions. These catheters have been left in place for as long as 2 weeks for infusions of cancericidal drugs in other series of patients.<sup>18</sup>

Although a patient with a massively bleeding gastric ulcer was successively controlled by selective infusion of vasopressin into the left gastric artery, one must be cautious with the infusion of vasopressor substances in the control of arterial bleeding. It is apparent that this type of infusion to be successful must be in a subselective vessel more directly feeding the area of bleed. Infusions more proximal into the main trunk of the celiac axis or superior mesenteric artery will increase peripheral vascular resistance and may actually increase the rate of bleeding as was demonstrated in one patient. In addition, the possibility of producing mucosal ulcerations on the basis of vascular insufficiency must be considered although in the patient presented, this did not occur and the collateral circulation was adequate to nourish surrounding mucosa.

As experience has developed in our institution with the technics of selective mesenteric arteriography and in particular the technics of the demonstration of massive bleeding from the gastrointestinal tract, it has become customary to make the mesenteric arteriogram a primary study in the approach to the bleeding patient. The utilization of barium as a primary study will often prevent the use of subsequent angiography due to the retention of barium in various portions of the gastrointestinal tract.

### Summary

Clinical experience with the utilization of mesenteric arteriography in the diagnosis and management of gastrointestinal bleeding has been presented. Representative cases have been shown and a summary of the results have been included.

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