Renal-splanchnic steal

Report of a Case

Ralph J. Alfidi, M.D., Edgar J. Filson, M.D.,
Department of Hospital Radiology

Edward D. Frohlich, M.D.,
Division of Research

Ray W. Gifford, Jr., M.D., and
Department of Hypertension and Renal Disease

Thomas F. Meaney, M.D.
Department of Hospital Radiology

HEMODYNAMIC detours resulting from vascular occlusive disease are currently the object of great interest. Recently we have examined a young hypertensive patient in whom studies have yielded considerable evidence indicating that a renal-splanchnic steal is present and functioning.

Report of a Case

First admission to the hospital. A 31-year-old white woman with a history of frequent headaches, flushing, and diaphoresis, for six months, was first admitted to the Cleveland Clinic Hospital on December 28, 1965. Several weeks after the onset of the symptoms, believing that she might be pregnant, she consulted a physician. Her blood pressure was 195/128 mm Hg. Investigation disclosed *Escherichia coli* infection of the urinary tract and a negative pregnancy test. Four months previous to this episode she consulted another physician and underwent laparotomy and wedge resection of a single right ovary for suspected Stein-Leventhal syndrome; the blood pressure at that time was normal.

In December 1965, physical examination revealed an abdominal bruit. Angiograms obtained at that time demonstrated complete occlusion of the celiac axis, a dilated left colic "wandering" artery, and questionable stenosis of one of two left renal arteries. Late that month she was admitted to the Cleveland Clinic Hospital for further angiographic evaluation. The blood pressure was 172/122 mm Hg. The retinal arteries showed constriction but no exudates or hemorrhages. A high-pitched continuous bruit was present in the left upper quadrant, and a systolic bruit in the right upper quadrant. Significant laboratory findings included 0.36 g of protein per liter of urine, and a positive urine culture (420,000 colonies of *Streptococcus fecalis* and *Proteus vulgaris*). Catecholamine and vanillylmandelic acid (VMA) values were normal.

Angiograms obtained in January 1966 revealed complete occlusion of the origin of the celiac axis (*Fig. 1*). Collateral flow from the superior mesenteric artery filled the celiac axis in retrograde fashion through dilated gastroduodenal and inferior pancreatic arteries (*Fig. 2*). A dilated left colic wandering artery (*Fig. 3 and 4*) was observed which entered the superior mesenteric artery approximately 4 cm distal to its origin. Numerous small collateral arteries were present above the origin of the left renal artery emanating from the aorta.

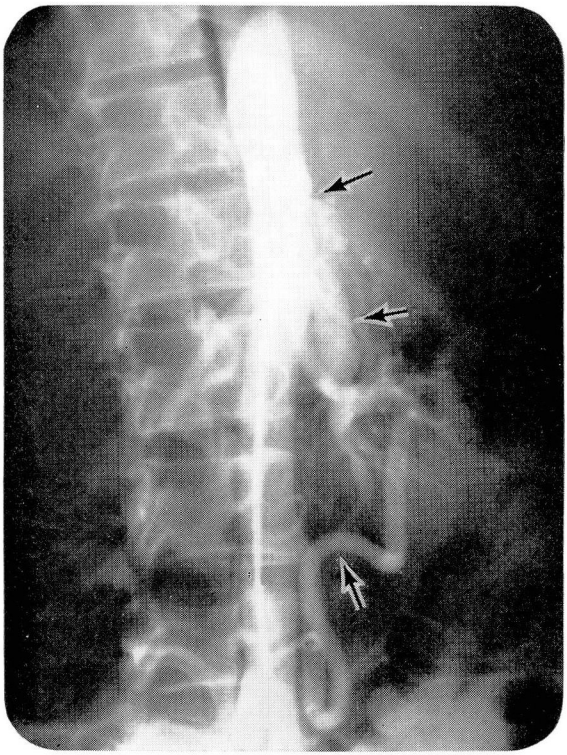

Fig. 1. Lateral aortogram showing occlusion of the celiac axis (upper arrow), dilatation of the proximal portion of the superior mesenteric artery (middle arrow) and dilated left colic wandering artery (lower arrow).

Both left renal arteries were normal. There was, however, moderate irregularity of the peripheral arteries on the left side.

Selective injection of the right main renal artery demonstrated no evidence of stenosis. A dilated and tortuous artery was present which originated 1 cm distal to the take-off of the right renal artery (*Fig. 5*). It gave off several small branches to the right adrenal gland, and a large capsular branch that proceeded on a tortuous course superimposing the lateral margin of the right kidney (*Fig. 6*). Cineradiography of the same vessel did not demonstrate its exact termination, but the vessel appeared to end abruptly near the midline.

A radiorenogram was obtained and demonstrated a prolonged functional phase on the left side. The right kidney curve was depressed, but showed no evidence of abnormality in contour.

Briefly then, the findings at this time were hypertension and urinary tract infection. The following conditions were demonstrated arteriographically: occlusion of the celiac axis with retrograde filling from the superior mesenteric collateral vessel; collateral flow from the inferior mesenteric artery to the superior mesenteric artery; normal main renal arteries bilaterally, with peripheral arterial irregularity on the left kidney; and a large right renal capsular collateral artery originating from the right renal artery and apparently terminating near the midline. The right kidney was 1.3 cm shorter than the left. The patient was discharged from the hospital and was asked to return in five months for further study and evaluation.

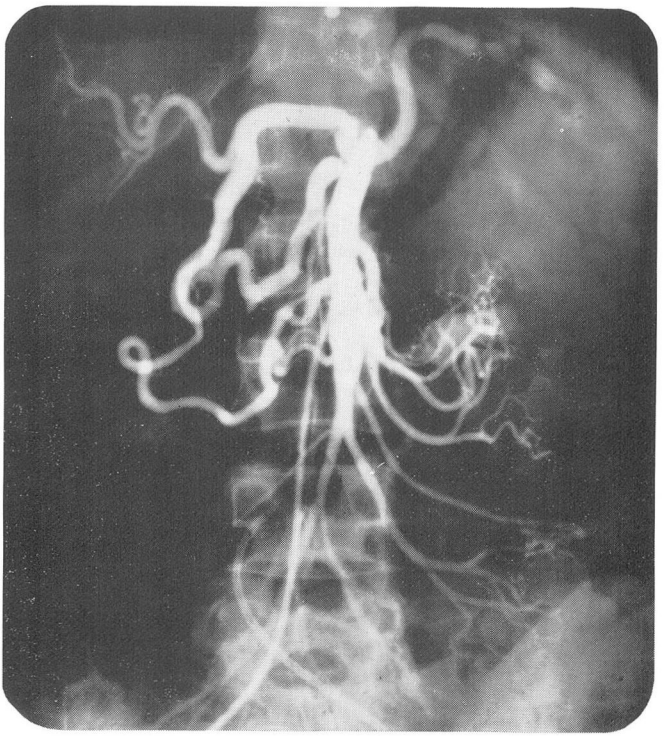

Fig. 2. Selective superior mesenteric angiogram, performed with a single-end-hole catheter, showing large collateral vessels from the superior mesenteric artery supplying the celiac axis through a dilated gastroduodenal artery.

Second admission to the hospital. After five months the blood pressure was 168/106 mm Hg supine and 148/112 mm Hg standing. Angiographic studies were repeated, with emphasis on the large right renal capsular vessel previously described. Selective catheterization of the vessel demonstrated intense opacification of the right adrenal gland (*Fig. 7*). After injection, the catheter was immediately withdrawn and the course of the collateral vessel followed cineradiographically. The vessel divided into two branches (*Fig. 8*). Contrast medium disappeared rapidly at the distal end of the first branch in the region of the gastroduodenal collateral vessel leading from the superior mesenteric artery to the celiac axis (*Fig. 9*). The second branch followed the course of the right gastroepiploic artery, its terminal branches appeared to arborize in the gastric wall (*Fig. 10*). Renal blood flow studies using indocyanine green dye[1] were performed after arterial and venous catheterization, but before injection of contrast medium. Right renal blood flow was 337 ml per minute, and left renal blood flow was 527 ml per minute. Because of the dual arterial blood supply to the left kidney, these values must be interpreted with caution; however, dye was injected into the larger of the two vessels, and collected from the main left renal vein. Arterial pressures in the aorta, and in the right and left renal arteries were 154/104 mm Hg, 142/96 mm Hg, and 148/104 mm Hg, respectively. Cardiac output was 5.5 liters per minute, and cardiac index, 3.2 liters per minute per square meter. Split renal-function studies were performed, and demonstrated no significant difference in urine volumes or in concentrations. Twelve-hour urine protein content was 0.2 g per liter. An Addis count showed 200,000 erythrocytes and 1,000,000 leuko-

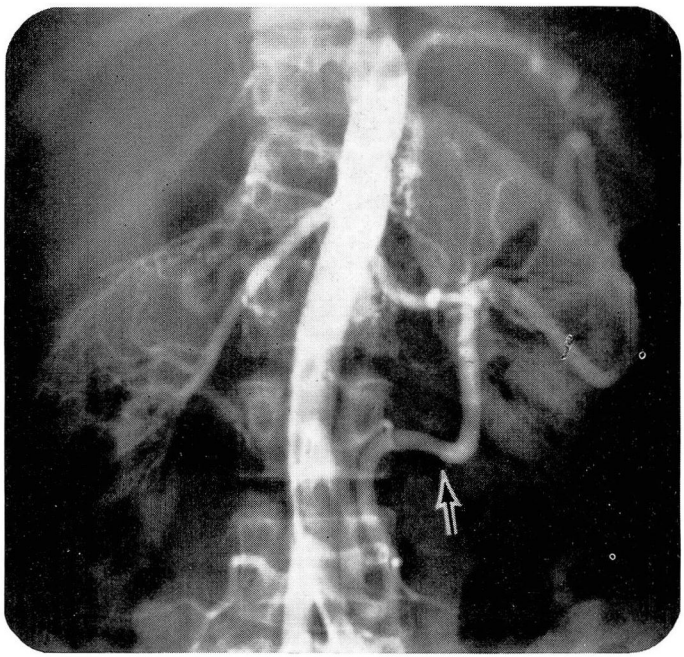

Fig. 3. Early phase of an aortogram demonstrating the proximal portion of the dilated left colic artery (arrow).

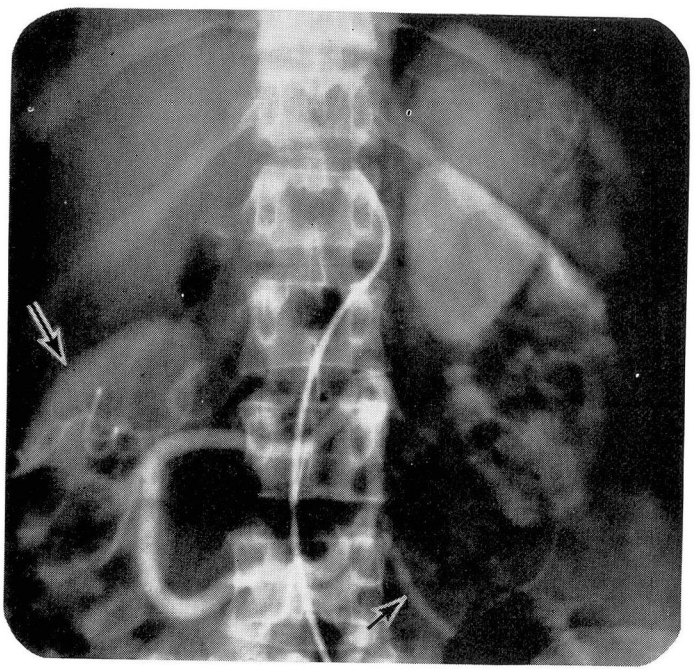

Fig. 4. Later phase of the aortogram in *Figure 3,* with filling of the distal portion of the superior mesenteric artery distribution from the wandering left colic artery. Small arrow indicates tortuous renal capsular artery responsible for renal steal pathway.

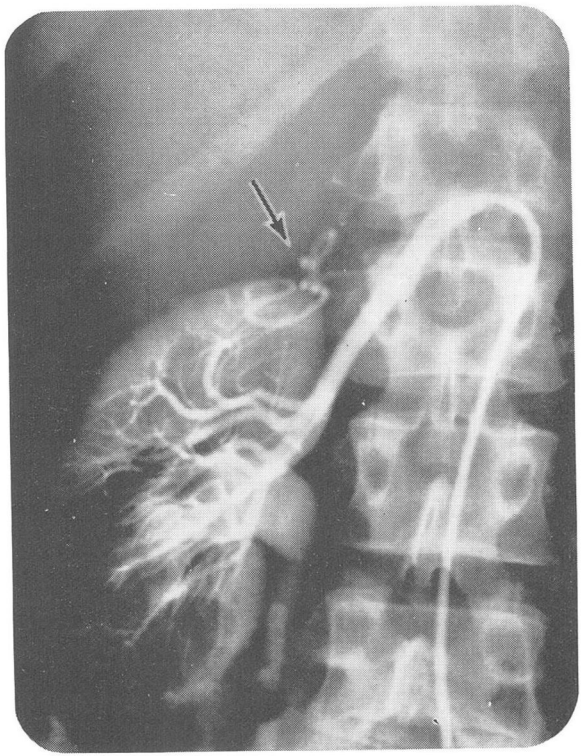

Fig. 5. Selective right renal angiogram showing a normal main artery with early filling of renal capsular artery (arrow).

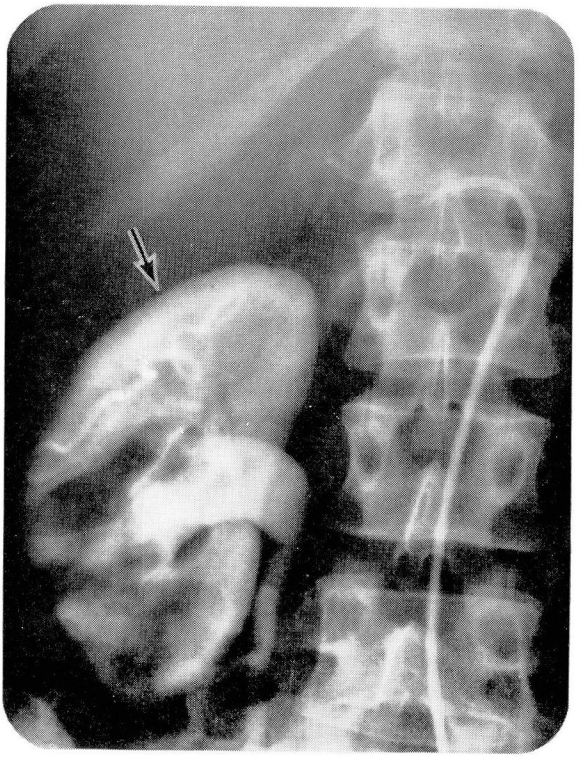

Fig. 6. Late phase of same injection as that for *Figure 5,* showing the tortuous course of the renal capsular artery.

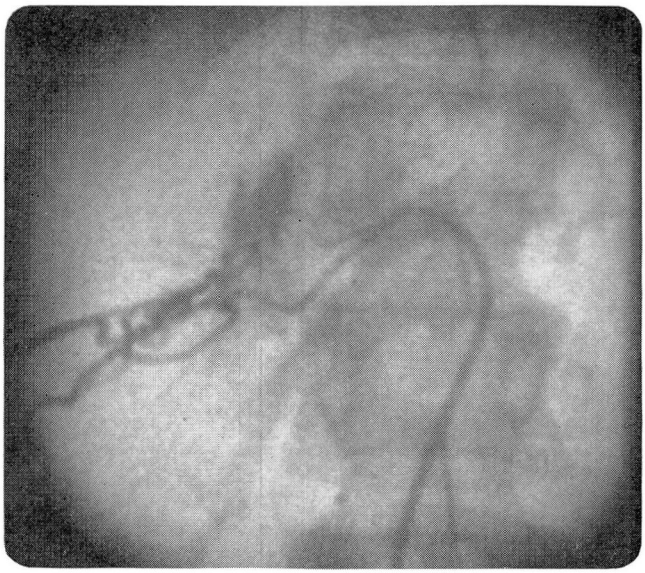

Fig. 7. Cineradiographic frame of early phase after selective catheterization of renal capsular steal vessel at point of origin from the right renal artery. There is faint filling of the main right renal artery. (This study was performed with a single-end-hole catheter.) Staining is intense in the region of the right adrenal gland. The artery continues as a tortuous capsular vessel superimposing the lateral margin of the right kidney.

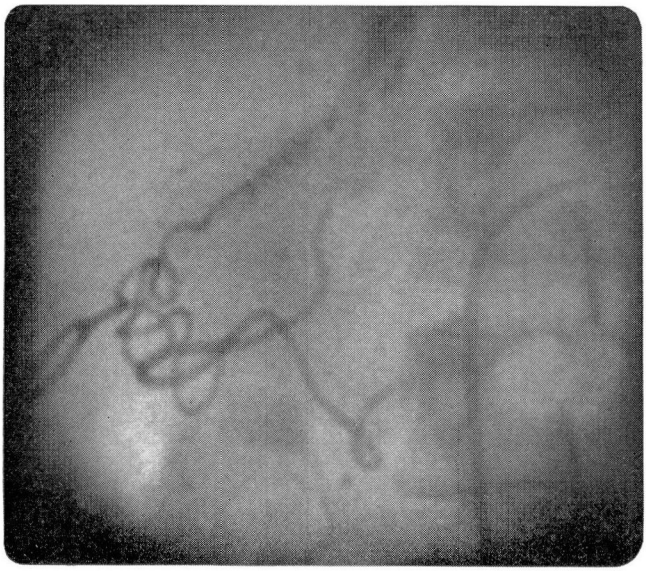

Fig. 8. Later phase (than *Figure 7*). The catheter had been removed from the capsular artery, allowing free flow. The capsular vessel has branched, and contrast medium disappeared rapidly at the distal end of the upper branch as it entered the gastroduodenal artery.

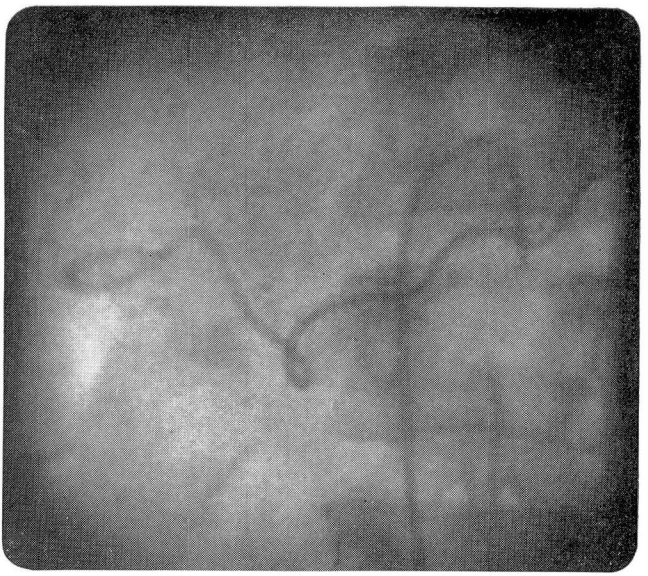

Fig. 9. Later phase (than *Figure 8*) showing the lower of the two branches crossing the midline.

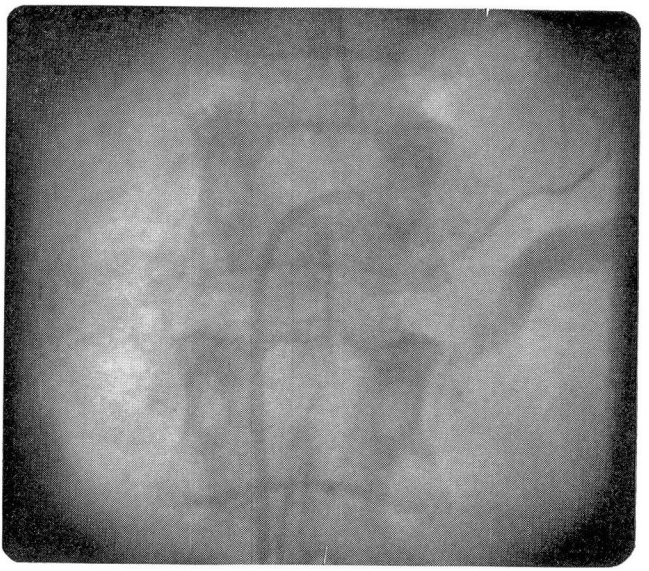

Fig. 10. Arborization of the lower branch of the renal capsular artery in the region of the gastric wall.

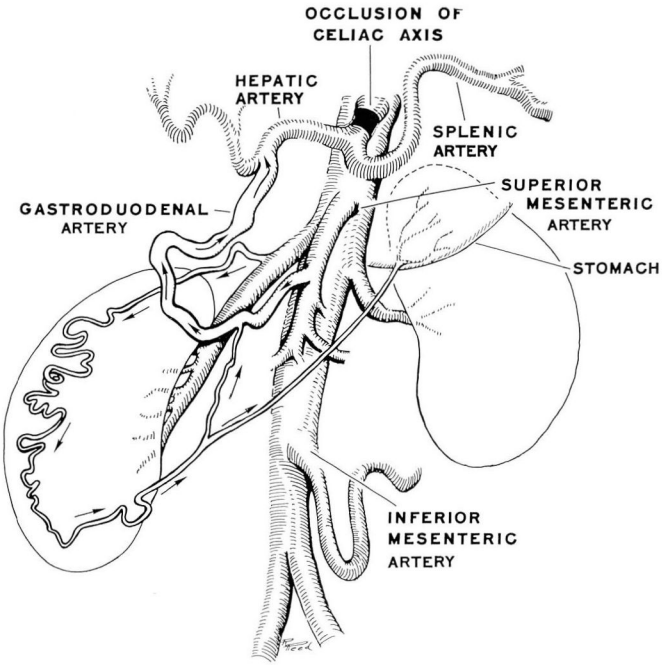

Fig. 11. Diagrammatic summary showing occlusion of the celiac axis with resulting collateral flow from the superior mesenteric artery and the right renal artery. Arrows demonstrate the direction of flow.

cytes per 12 hours; no casts were present. The renogram was unchanged from that of the previous study. The patient was discharged from the hospital and was asked to return in one year.

DISCUSSION

Collateral circulation *to* the kidney has been described by Abrams and Cornell[2] and by Paul and associates.[3] The patient we report here is unique in that collateral circulation emanating *from* the right renal artery was shown to supply blood to the organs originally perfused by the currently occluded celiac axis. It is tempting to attribute the hypertension to a renal-splanchnic steal mechanism. Thus, it is suggested that the large right renal collateral capsular artery is shunting blood away from the right kidney through the collateral gastroduodenal vessels to the celiac distribution. The presence of urinary tract infection and the peripheral vascular changes in the left kidney make this hypothesis less tenable.

Nonetheless, it is significant that collateral circulation to the splanchnic bed, originating from the right renal artery, and decreased right renal blood flow were demonstrated.

Summary

A hypertensive patient had celiac axis occlusion with radiographic and hemodynamic evidence of partial revascularization from the right renal artery. Decreased renal blood flow, as a result of renal-splanchnic steal, may have participated in the development of hypertension, but other factors were also present.

References

1. Cohn, J. N., and Gombos, E. A.: Unilateral renal hemodynamics studied by an indicator-dilution technic in man. Am. J. Cardiol. **16:** 820–827, 1965.

2. Abrams, H. L., and Cornell, S. H.: Patterns of collateral flow in renal ischemia. Radiology **84:** 1001–1012, 1965.

3. Paul, R. E., Jr.; Ettinger, A.; Fainsinger, M. H.; Callow, A. D.; Kahn, P. C., and Inker, L. H.: Angiographic visualization of renal collateral circulation as a means of detecting and delineating renal ischemia. Radiology **84:** 1013–1021, 1965.