Splenorenal Arterial Anastomoses

By Elliott S. Hurwitt, M.D., Bernard Seidenberg, M.D., Henry Haimovici, M.D., and Donald S. Abelson, M.D.

A splenorenal arterial anastomosis may be life-saving or result in renal salvage under a variety of circumstances. These may include thrombosis or aneurysm of the aorta, and obstruction, injury, aneurysm, or anomalies of the renal artery. The successful construction of a left splenorenal arterial anastomosis in a patient with ascending thrombosis of the abdominal aorta is presented.

The term "splenorenal shunt" has acquired general acceptance as an anastomosis between the splenic and renal veins, designed to accomplish portal decompression in selected cases of portal hypertension. Little attention has been paid to the unexploited potentialities of the splenic artery as a source of an arterial blood supply to other intra-abdominal viscera. This large artery to an expendable organ has previously been demonstrated to be an adequate replacement for the hepatic, superior mesenteric, or left renal arteries in dogs. Some of the clinical applications of the splenorenal arterial anastomosis in a variety of disease states and an account of the first such operation with a successful outcome in a patient constitute the basis for this report.

The potential indications for a splenorenal arterial anastomosis are (1) aortic thrombosis (Leriche's syndrome; unresectable); (2) aortic aneurysm; (3) renal artery obstruction; (4) renal artery injury; (5) renal artery aneurysm; (6) anomalous renal artery.

Aortic Thrombosis

The treatment of choice for thrombosis of the aorta localized to the region of the bifurcation is resection of the involved segment and replacement with an arterial graft or prosthesis. Significant extension of the thrombotic process either proximally or distally has limited the number of cases suitable for such definitive therapy. Thromboendarterectomy used in conjunction with grafting has not always provided a solution to this problem. For example, the lack of an adequate run-off for the flow of aortic blood into the legs, due to oblitative disease extending into the iliac, femoral, and distal arteries, has resulted in thrombosis of grafts. On the other hand, ascending aortic thrombosis with eventual involvement of the renal arteries has been observed, with fatalities due to renal failure or with the development of severe hypertension. A supply of arterial blood to the left kidney from the celiac axis may succeed in obviating or delaying some of these renal catastrophes.

Case Report

M. D., Montefiore Hospital Admission #67213, was a 44-year-old white man with a history characteristic of the Leriche syndrome, consisting of claudication, loss of sexual potency, and absence of pulsations in the lower extremities. A translumbar aortogram demonstrated complete obstruction of the aorta just below the origin of the inferior mesenteric artery (fig. 1A). The obliterated segment was resected and replaced with a preserved aortic bifurcation homograft on January 11, 1955. A considerable extension of the occlusive process into both iliac and femoral vessels necessitated liberal proximal and distal thromboendarterectomies; bilateral lumbar sympathectomy was also carried out. An aortogram on April 9, 88 days postoperatively, showed complete thrombosis of the infrarenal portion of the aorta and graft; the occlusion extending proximally to the level of origin of the renal arteries, and slightly higher on the right side (fig. 1B).

A left splenorenal arterial anastomosis was constructed on April 19, 1955, in the hope of preventing the anuria that would result, should the aortic thrombosis ascend even a few millimeters farther. With the patient turned slightly in the right lateral decubitus, a thoracoabdominal incision was made extending obliquely across the left upper quadrant from the midline, transecting the costal arch, and entering the left pleural cavity through the eighth rib.

From the Surgical and Laboratory Divisions, the Montefiore Hospital, New York, N. Y.

* Supplied by the New York Blood Vessel Bank.
interspace. The diaphragm was divided in the direction of its fibers (fig. 2). The spleen was slightly enlarged and adherent to the diaphragm posteriorly. The spleen was mobilized posteriorly and inferiorly, and the vasa brevia were divided, leaving the spleen attached only to its pedicle. The main splenic artery was mobilized a short distance proximal to the hilus, and 3 large branches entering the hilus were similarly mobilized and cleared. The splenic artery was quite tortuous, but not calcified, and pulsed vigorously; it measured \( \frac{3}{8} \) of an inch in diameter. The spleen was amputated at the hilus, and the distal end of the splenic artery was clamped temporarily.

By a combination of blunt and sharp dissection the left renal vein was identified and the left renal artery mobilized close to its origin from the aorta. The renal artery pulsed vigorously, but the aortic pulsations stopped just below this level. The 2 main branches of the renal artery were also mobilized and temporarily retracted with loops of silk. The adrenal gland nested in the hilus of the left kidney, and both the gland and the kidney were elongated and narrow. The left renal artery measured \( \frac{3}{8} \) of an inch in diameter.

Two large branches of the splenic artery were ligated, a bulldog clamp was placed proximally, and the splenic artery was divided distally (fig. 3A). The stump was irrigated with heparin solution, after free bleeding was permitted for a few pulsations. The renal artery was doubly ligated practically flush with the aorta, a bulldog clamp was placed just proximal to the first major branching, and the renal artery was divided close to its origin (fig. 3B). The distal stump was similarly irrigated with heparin solution. An end-to-end anastomosis was effected between the proximal limb of the splenic artery and the distal limb of the left renal artery (they were both of the same size) with doubly armed sutures of 5-0* silk. The needles were passed from inside out in both vessels and all the knots were tied on the outside. After the angle sutures were placed, the posterior and anterior rows were constructed with continuous simple over-and-over sutures (fig. 4). The bulldog clamp on the renal artery was released, followed by the bulldog clamp on the splenic artery; there was slight transient bleeding, which was controlled by gauze, and no additional sutures were necessary. The duration of renal artery occlusion was 30 min. The kidney itself was not visualized, but bleeding from the perirenal tissue confirmed the impression of a good blood supply, and pulsations were felt in the main branches of the renal artery. The incision in the diaphragm was repaired with interrupted catgut sutures, and a standard closure of the thoracoabdominal wound was performed.

* Supplied through the generosity of the Ethicon Suture Laboratories, Inc., New Brunswick, N. J.
The postoperative course was complicated by a mechanical small intestinal obstruction, which required surgical correction. At operation there was no evidence of mesenteric thrombosis or vascular compromise of the small intestine. A stubborn cystitis developed that finally cleared with antibiotic therapy. Minor trauma to the toes of the left foot resulted in an ischemic ulceration that progressed to gangrene and eventually required a midleg amputation. Despite this series of major problems, at no time was there any clinical or chemical evidence of impaired renal function. Excretory urograms before operation and at intervals postoperatively indicated better visualization of the left kidney than the right. At 5 months there was no filling on the right side, suggesting cessation of function of the right kidney due to obstruction of the right renal artery, with a compensatory dilatation of the left calyceal system. However, an intravenous pyelogram 10 months after operation showed visualization of the right kidney that was even better than the preoperative status, with a return to normal size of the left renal pelvis. On that date the blood urea nitrogen level was 16 mg. per cent.

Twelve months following left splenorenal arterial anastomosis, the patient's nutritional status was excellent, and within the limitations of his amputation, he was active and getting along reasonably well. His blood pressure was 180/126 mm. Hg, as compared with preoperative readings ranging from 150/105 to 180/110. Fifteen months postoperatively both kidneys were functioning well, as indicated by intravenous pyelography, urinalysis, and blood urea nitrogen level.

**AORTIC ANEURYSM**

Resection of aneurysms of the abdominal aorta involving the region of the origins of the renal arteries has been handicapped by the dangers of simultaneous occlusion of both renal arteries for a period of time sufficient to remove the aneurysm, insert a graft, and reimplant the renal arteries. Ingenious clinical experiences have been described utilizing temporary bypass shunts in attempts to circumvent this problem, as well as replacement of other essential upper abdominal arteries. Utilization of the left splenorenal arterial anastomosis has been reported from this laboratory as a device for avoiding any period of bilateral renal arterial obstruction. Following performance of this procedure, the right renal artery may be re-
Fig. 3. Preparation of A splenic and B renal arteries.
Implanted either into the aorta more proximally, or into the graft (fig. 4). The latter technic approximates the clinical situation encountered by Ellis and co-workers, in which an ectopic right renal artery was anastomosed to the graft after resection of an aneurysm that did not involve the left renal artery. The availability of the splenic artery as a new blood supply for a solitary pelvic or horseshoe kidney originally deriving its blood supply from the lower abdominal aorta might provide a means for excising aneurysms in this situation, as in the cases described by Julian.

RENAL ARTERY OBSTRUCTION

The treatment of hypertension secondary to obstruction of a renal artery has usually consisted of nephrectomy. Recent reports describing such cases and summarizing previous experiences include those of Imber and Clymer and Poutasse. Freeman and associates and DeBakey have accomplished renal salvage in a few instances by performing thromboendarterectomy of the renal artery. A splenorenal arterial anastomosis would present the distinct advantages of wider range of applicability and elimination of a traumatized arterial surface predisposing to the reformation of thrombus. Provision of a new source of arterial blood that might reverse the hypertension of a Goldblatt kidney should be preferable to either nephrectomy or thromboendarterectomy. One unsuccessful effort to accomplish this was reported in 1952 by Thompson and Smithwick; it was followed by nephrectomy 17 days later. The account does not mention whether or not the splenorenal arterial anastomosis was patent; the renal parenchymal changes described were not striking. In instances of renal arterial obstruction associated with coarctation of the abdominal aorta, such as the case of Fisher and Corcoran, an effective relief of the hypertension might result from construction of a splenorenal arterial

Fig. 4. Technic of splenorenal arterial anastomosis.
FIG. 5. Avoidance of renal ischemia during aortic resection, by left splenorenal arterial anastomosis (A, B), followed by implantation of right renal artery either into aorta (C, D) or into graft (E, F). (Reproduced with the permission of the American College of Surgeons, from the Surgical Forum, 6: 248.)
anastomosis. The functional status of the kidney itself will, of course, be the decisive factor in these problem cases.

Renal Artery Injury and Renal Artery Aneurysm

The standard management of these lesions has consisted of sacrificing the involved kidney. In an elective procedure for a vascular problem in which the kidney itself is normal, such as in extrarenal aneurysms of the renal artery, such an organ may no longer need to be removed. It is realized that this attempted salvage would not be applicable to the renal arterial aneurysms near the hilum of the kidney where the artery branches. However, aneurysms arising near the aortic renal junction should provide a favorable opportunity, as in the case described by Pastor and co-workers.18 When faced with an acute arterial injury to a renal artery, the surgeon may well be able to save the kidney by a new arterial anastomosis. The procedure may also find an occasional application in the management of a patient who has sustained severe accidental trauma to a renal pedicle, although admittedly the duration of renal ischemia under such circumstances may often preclude any salvage. The maximum period during which a renal artery may safely be occluded in man is not known. In the case reported by Ellis and associates the right renal artery was occluded for 135 min. Our patient experienced an episode of nonvisualization of the right kidney of undetermined duration, several months postoperatively, followed by return of good function. If this were on the basis of temporary arterial insufficiency, with subsequent restoration of adequate flow, the maximal period of arterial occlusion compatible with recovery may be sufficiently long to permit the application of this salvage procedure in cases of acute injury. Burch and associates19 have suggested that the maximum safe time for aortic occlusion above the renal arteries in dogs is 60 min.

The same considerations apply to potential kidney salvage in dealing with arteriovenous fistulae involving the renal vessels, by construction of a splenorenal arterial anastomosis. Baron and Koenemann20 have recently reported the fifth verified example of renal arteriovenous fistulae, and the first case proved to be of traumatic origin. When the lesion is actually intrarenal, as in most of the reported cases, nephrectomy is necessary.

Anomalous Renal Artery

Such a vessel, crossing the upper ureter or renal pelvis, may be a cause of substantial hydronephrosis. Division of the obstructing vessel has been avoided for fear of causing infarction of that portion of the kidney supplied by the anomalous artery. Urologists have approached the problem either by nephrectomy or by division and reconstruction of ureteropelvic continuity. Although the vessel may be small, this situation would seem to afford an ideal opportunity for a splenorenal arterial anastomosis, eliminating the abnormality at its source, and avoiding urologic procedures that have been associated with a high incidence of failure.

Discussion

Survival experiments in dogs subjected to right nephrectomy and a left splenorenal arterial anastomosis, have demonstrated that the splenic artery can deliver an amount of blood to a kidney adequate to sustain normal existence.1 The first successful human splenorenal arterial shunt apparently tided the patient over a temporary period of right renal suppression, as evidenced by nonvisualization of the right kidney by intravenous pyelography during one phase of his postoperative course. The splenic artery was rarely found to be anatomically unsuitable for renal arterial anastomosis in the experiments in this laboratory.1, 9 Comparative measurements of the caliber of the splenic and renal arteries in human beings have been made in the autopsy room: in a series of 39 consecutive cadavers, no significant disparity in the size of these vessels was found that would preclude the possibility of a satisfactory anastomosis. However, there were 3 instances of generalized arteriosclerosis of such severity that it is doubtful, technically, if a competent anastomosis could have been constructed.

Utilization of the splenic for the left renal artery in cases of aortic obstruction leaves the problem of right renal arterial replacement
unsolved. It may be hoped that the full force of aortic blood pressure directed at the origin of the right renal artery, after ligation of the left renal artery, might keep this vessel open. Management of the right renal artery when involved in aortic aneurysms has already been discussed. Involvement of the origin of the right renal artery by an occlusive process, injury or aneurysm, or anomalous right renal arteries requires a source for a new arterial blood supply. In the dog this has been accomplished by utilizing either the splenic or the inferior mesenteric arteries. The latter vessel would seem to have a greater potential applicability in human beings, and this impression has been substantiated by postmortem observations. Variations in the number of renal arteries have been noted in dogs and reported in human beings, a fact that should be kept in mind in any consideration of vascular replacement.

SUMMARY

The indications for splenorenal arterial anastomoses have been presented and its successful construction in a case of ascending thrombosis of the aorta has been described.

It is believed that this procedure may occasionally be life-saving and that significant renal salvage may be achieved in a variety of situations.

SUMMARIO IN INTERLINGUA

Es presentate le indicationes pro anastomoseis arterio-splenorenale. Le construction de un anastomosis arterio-splenorenale sinistre es describile. Nos opinia que iste technica es a vices un salva-vita e que illo pote effectuar significativos grados de salvagio renal in un varietate de situationes.

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