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John R. Caldwell

Roger F. Smith

D. Emerick Szilagyi

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RENAL ARTERIAL RECONSTRUCTION IN THE TREATMENT OF HYPERTENSION DUE TO RENAL ARTERY STENOSIS

JOHN R. CALDWELL, M.D.,* ROGER F. SMITH, M.D.** AND
D. EMERICK SZILAGYI, M.D.**

In the past decade we have witnessed remarkable improvement in methods for the diagnosis of renal arterial disease as well as in surgical techniques. Although we have diagnosed renal artery stenosis by arteriography in many patients with high blood pressure, we have been conservative in recommending surgical treatment. This is in part because of the success of antihypertensive drug treatment of patients with hypertension due to renal artery stenosis and to avoid undue risk from operative procedures in patients with hypertension. An established diastolic hypertension may certainly be due to renal artery stenosis. We have proved this by corrective surgery which resulted in restoration of normal blood pressure lasting for years after operation. This experience has been reported by many others throughout this country.[1-3] Reporting our experience has helped us to evaluate the effectiveness of reconstructive procedures in correction of hypertension and improvement of renal function when these abnormalities are due to renal artery stenosis. We are reporting a one to five-year follow-up of 30 patients (Table I) who had renal arterioplasty for treatment of established diastolic hypertension between the years 1960 to 1965. All these patients had a basal diastolic blood pressure of 90 mm.Hg. or above. Most of them had left ventricular hypertrophy, some had Grade III or IV retinopathy and a few had azotemia.

Table I

DIAGNOSTIC CLASSIFICATION OF 30 CASES OF RENAL ARTERY STENOSIS

By Etiology	
Atherosclerotic	23
Fibromuscular hyperplasia	7
By Blood Pressure	
Established diastolic hypertension	30
By Severity of Disease	
Hypertensive Cardiovascular Disease	20
with gr. III or IV retinopathy	7
with azotemia	5
Hypertensive vascular disease	10

*Division of Hypertension.
**Department of Surgery, Division II.

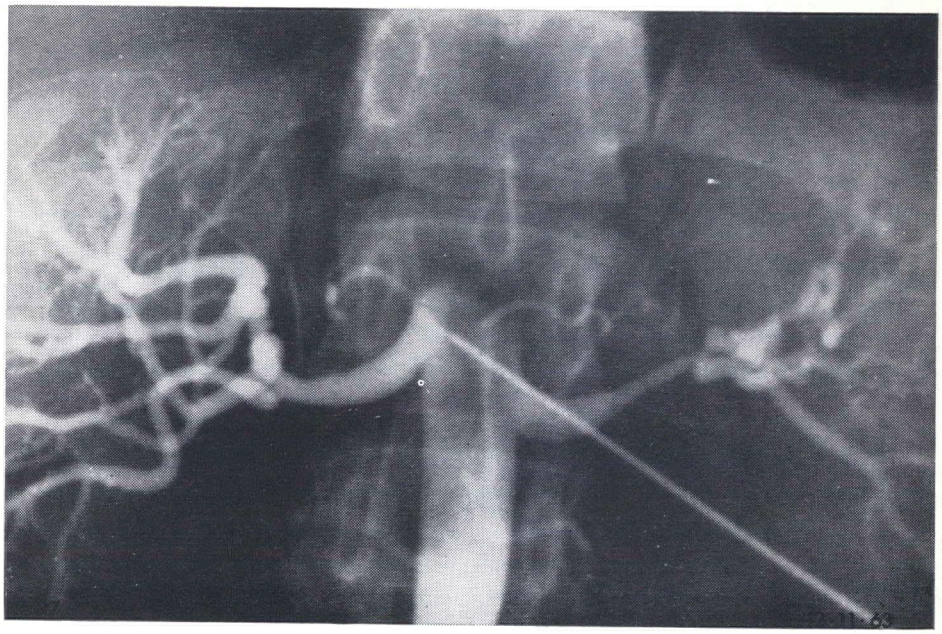

Figure 1

Renal arteriogram showing tapered narrowing of the middle 1/3 of the left main renal artery to a high grade stenosis as a result of fibromuscular hyperplasia. There is a string of beads or accordion-pleated appearance of a segment of the superior branch of the right renal artery.

Type of Renal Arterial Disease

In seven of the patients the renal arterial disease was fibromuscular hyperplasia. This was particularly common in younger patients, especially women. It was often associated with an abrupt onset of hypertension and the most remarkable physical finding was usually a loud, upper abdominal murmur often continuous in period and high-pitched in quality. The arteriographic finding (Figure 1) was usually a corrugated appearance of branches of the renal arteries with stenosis involving the middle one-third or distal two-thirds of the renal arteries. By contrast, a larger number (23 patients) had atherosclerosis as the cause of the renal artery disease, present more frequently in men and older patients. These lesions were most often located in the proximal one-third of the artery close to the ostium (Figure 2) and were frequently associated with atherosclerotic plaques in the aorto-iliac tree.

Blood Pressure Changes After Renal Arterioplasty

The blood pressure changes after renal arterioplasty (Table II) in the one to five-year follow-up period can be divided into cured, improved, unimproved and died. In the cured group were 13 patients who had average preoperative basal blood pressures of 182/106. At the end of one year all except two had a casual diastolic blood pressure below 90 without drugs. The average postoperative casual blood pressures was 126/77, the average difference in millimeters of mercury being -56/-29. Two of these patients were on thiazide drug treatment, but are classified as cured because they previously

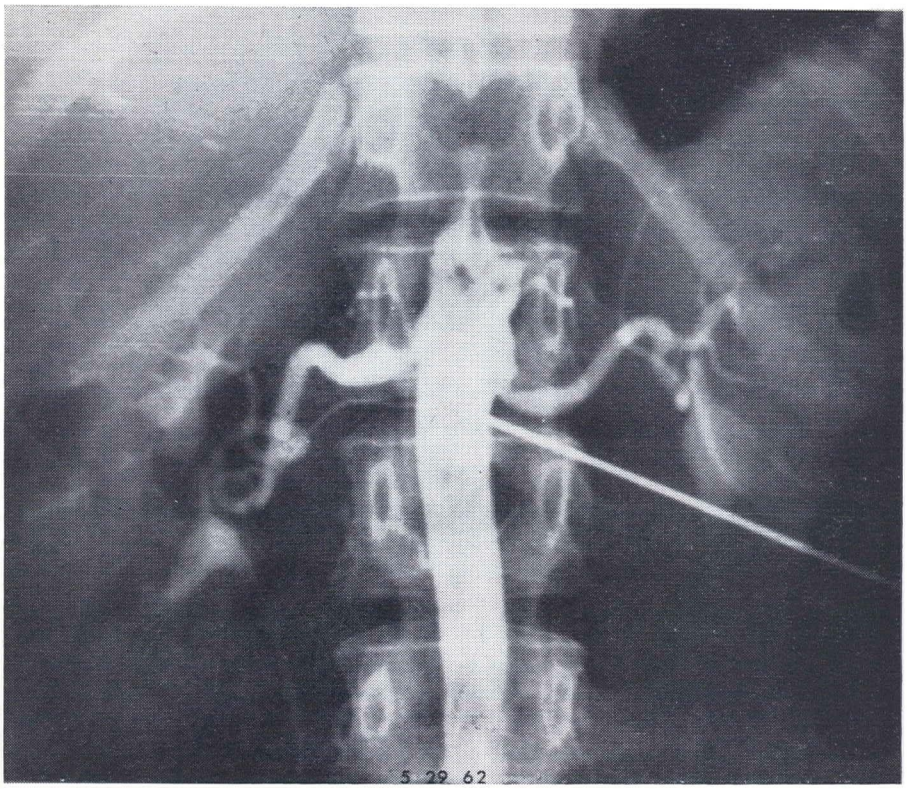

Figure 2

Bilateral atherosclerotic renal arterial stenosis close to ostia. There is a ++ or 50% obliteration of the left and a +++ or 75% obliteration of the lumen on the right with poststenotic dilatation in both main renal arteries.

had required more potent antihypertensive drugs. The casual blood pressure reading was used in the postoperative evaluation to emphasize the effectiveness of the treatment when compared with the higher basal blood pressure levels preoperatively. Technique for basal blood pressure determination is according to a method previously described.[4] Ten patients were improved. Their preoperative basal blood pressure was 198/109 and postoperative blood pressure 156/91, with an average difference of -42/-18

Table II

BP CHANGES AFTER RENAL ARTERIOPLASTY

1-5 Yr. Follow-up

Number of Cases	Number on Drugs	Classification	Preop. Basal BP	Postop. BP	Ave. △ mm. Hg.
13	2	"Cured"	182/106	126/77	−56/−29
10	8	Improved	198/109	156/91	−42/−18
5	4	Unimproved	152/96	181/104	+29/+8
2	—	Died	190/115	—	—

mm.Hg. Eight were on antihypertensive drugs, usually a thiazide or a rauwolfia derivative. Five patients were unimproved, with a preoperative basal blood pressure of 152/96 and postoperative blood pressure of 181/104, representing an increase of +29/+8, although four were on antihypertensive drugs. Two patients died. Their preoperative basal blood pressure was 190/115. One died from postoperative pulmonary embolus and the other from technical failure with bilateral renal artery thrombosis.

Cardiovascular renal changes were evaluated after renal arterial reconstruction in the 30 patients operated upon (Table III). Whereas 100% had basal diastolic blood pressure of 90 mm.Hg. or above before operation, at one year or more after operation the casual diastolic blood pressure was below 90 mm.Hg. in 20 (66%). Electrocardiographic evidence of left ventricular hypertrophy was present in 20 (66%) of the group and this reverted to normal after successful revascularization in 6 (30%) of these. Seven of the patients (23%) had funduscopic findings of Grade III or IV KWB* retinopathy, and this reverted to Grade II or I retinal arterial changes in four (57%). Five (17%) had azotemia with a serum creatinine of 2 mg.% or above and the serum creatinine was reduced by greater than 0.6 mg.% in three (60%) of the azotemic patients. These observations emphasize that, with restoration of normal blood pressure, reversal of retinal, cardiac and renal changes due to high blood pressure may occur.

Table III

CARDIOVASCULAR RENAL CHANGES
AFTER RENAL ARTERIAL RECONSTRUCTION

30	100%	Basal dias. BP > 90 mm. Hg.	Casual dias. BP < 90 mm. Hg.	20	66%
20	66%	EKG - LVH	Normal	6	30%
7	23%	Fundi Gr. III or IV	Gr. II or I	4	57%
5	17%	Serum creatinine > 2.0 mg.%	Reduced by > 0.6 mg.%	3	60%

Clinical Findings

To emphasize the clinical findings in the cases which benefited most by surgical treatment, we noted the most common findings in the 23 improved patients of which 13 were cured and 10 were improved. An abrupt onset of blood pressure elevation or a recent exacerbation of pre-existent hypertension was present in 14 of the 23 (61%). An abdominal murmur of unusual character was present in 16 of the 23 (70%). The most significant characteristics of murmurs were a high pitch, a continuous murmur, a loud murmur and sometimes localization over the renal artery involving a high grade stenosis.[5] It should be emphasized that 30% of patients with surgically correctable renal artery stenosis did not have an abdominal murmur of remarkable character. Headache was present in 17 of the 23 (74%).

Intravenous pyelographic abnormalities were present in 17 of the 23 (74%). This usually consisted of a delay in the appearance time of the dye, a reduction in the size of the affected kidney or a reduced nephrogram effect. In a few cases there

*Keith-Wagener-Barker.

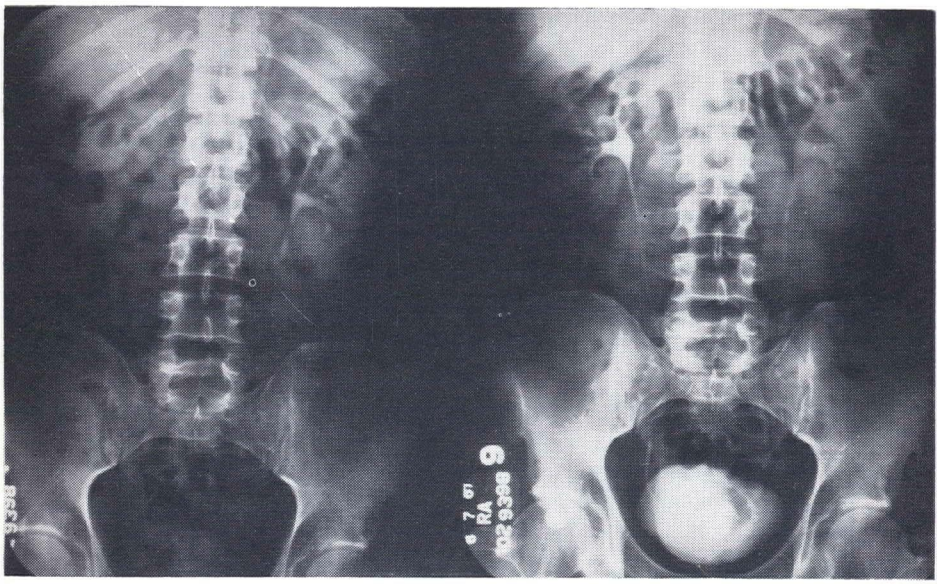

Figure 3

Rapid sequence intravenous pyelogram showing delay in the appearance time of the dye in the calyceal system of the right kidney on the 1 min. film. At a 9 min. film there is hyperconcentration of the dye. These changes were due to 3+ ostial stenosis and were reversed to normal after successful arterioplasty.

was hyperconcentration of the dye (Figure 3) in the late film. Rapid sequence intravenous pyelograms were used in all cases with frequent appearance of dye in the one- or two-minute films on the affected side.

The excretory urograms have been valuable for showing many types of anatomical details. However, specific abnormalities attributable to renal artery stenosis were present in just about one half of the examinations done. Only ten of the patients had follow-up urograms, three showed improvement, one showed return to normal, two showed no change and four showed deterioration as shown by a decrease in kidney size or delay in appearance of contrast material.

The radioisotope renogram was abnormal in 21 of 23 (91%). These abnormalities usually took the form of delay in peak time, reduced amplitude of the peak or loss of the concave upward characteristic of the descending limb in the "excretory phase". Asymmetry of the two curves was present when unilateral main renal artery stenosis was present (Figure 4) and with bilateral abnormalities there was an asymmetry usually with the greatest abnormality on the side with the higher grade stenosis. The renogram should be interpreted by independently evaluating each side in comparison with the normal standards. It is highly significant that in this operated group of patients no symmetrical normal renograms have been obtained. The asymmetrical renograms with either one side normal and one abnormal, or with bilateral abnormality

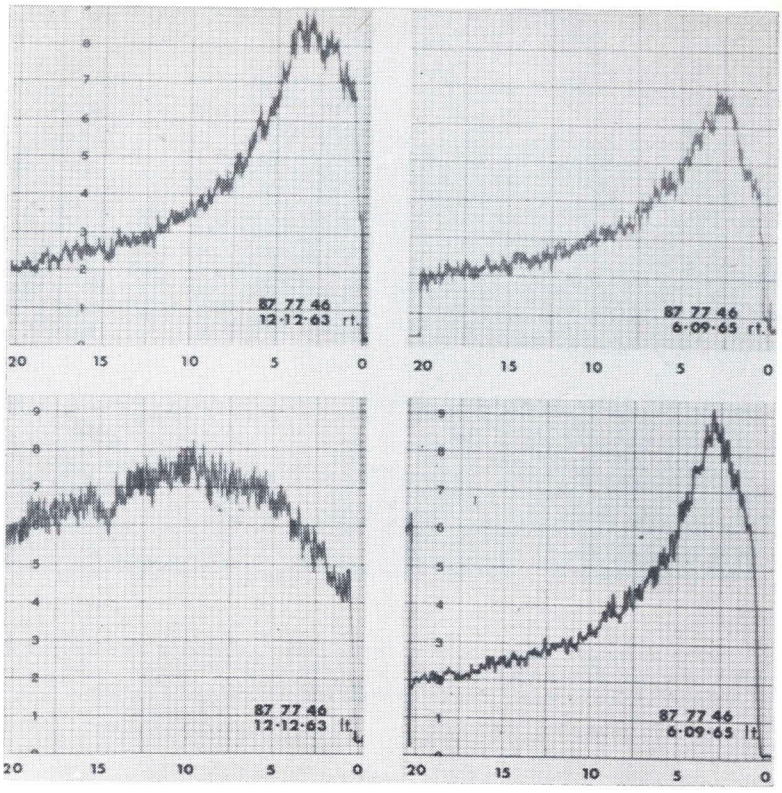

Figure 4

Radioisotope renogram on patient whose arteriogram is shown in Fig. 1. Asymmetry of the curves is notable. On the left side with high grade stenosis of the renal artery (preop 12-12-63) there is a delay in peak time to 10 min., reduced amplitude of the peak, and the descending limb of the curve is convex upward or straight. These changes were reversed to normal (postop 6-9-65) after successful renal arterioplasty.

more marked on one side and without mechanical embarrassment to urinary drainage or infection, have all had major arterial stenosis. Preoperative and postoperative renograms were helpful in estimating function of one or both kidneys after surgery. In postoperative cases showing a rise in blood pressure or those suspected of having renal ischemia, a radioisotope renogram showed the presence or absence of function in the separate kidneys. Reversal of specific abnormalities on the side of renal artery reconstruction was seen and, in addition, improvement in function of the contralateral kidney was observed.

Precise diagnosis was made by angiography, either percutaneous transfemoral renal arteriography or translumbar aortography. Renal arteriography revealed a high grade stenosis with Grade III or more main stem stenosis in 19 of 23 (82%) of the improved cases. Grade III stenosis represents at least 75% or more narrowing or obliteration of the lumen.

Types of Procedure Done

The operations performed for angioplasty were endarterectomy (Figure 5) in nine, grafting operation (Figure 6) in eight. Of these, two were replacement and six bypass operations. Transposition (Figure 7) was done in five cases, splenorenal anastomosis (Figure 8) in two, and nephrectomy, after unsuccessful angioplasty, in six. The number of bilateral operations was four; whereas, 26 had a unilateral operation. According to the type of disease, of the seven patients with fibromuscular hyperplasia two were cured, three improved, two unimproved, and none died. With atherosclerosis 11 were cured, seven improved, three unimproved and two died.

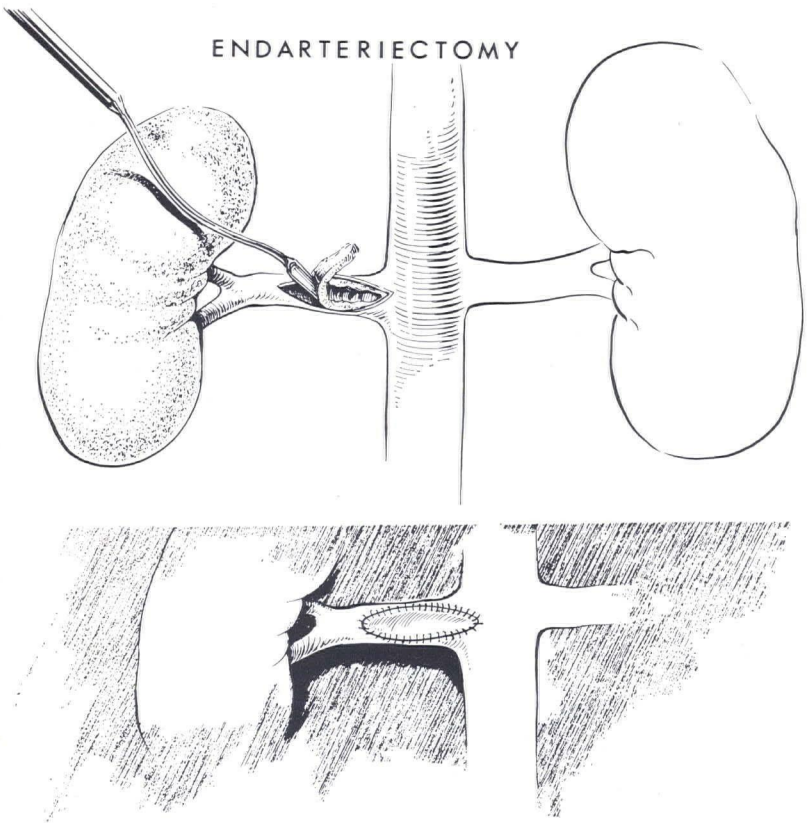

Figure 5

An artists's sketch depicting an endarterectomy of the proximal right renal artery. The atheromatous plaque must be removed well into the aortic wall. Reconstruction of the arteriotomy usually is best accomplished by means of a Dacron patch graft.

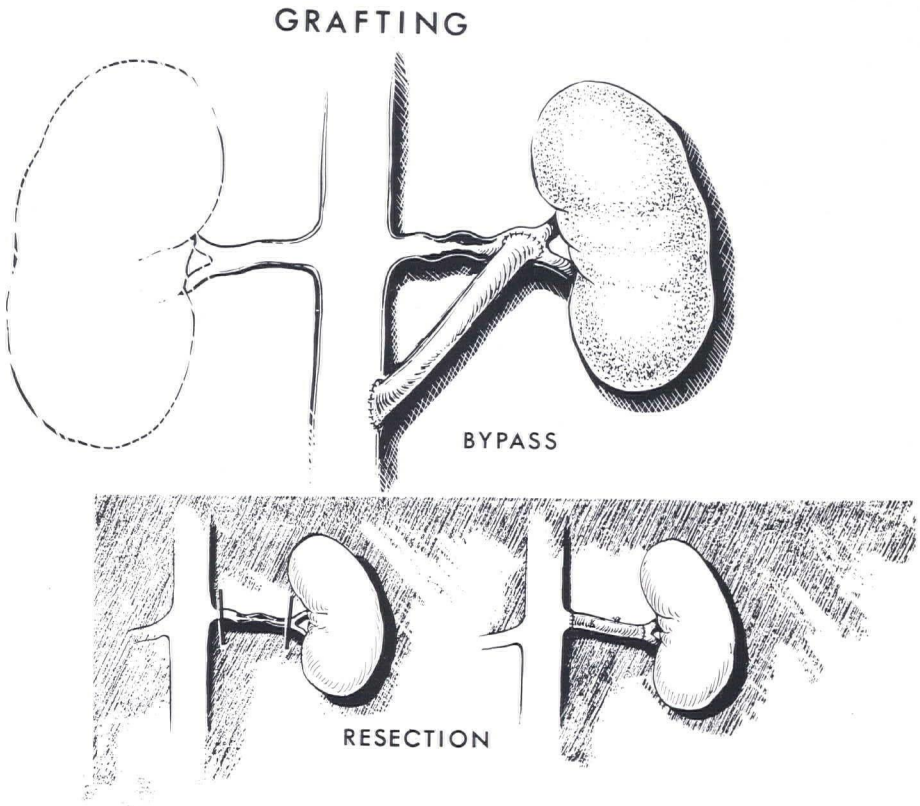

Figure 6

This illustration portrays two types of grafting operations. The left aortorenal bypass shown above is commonly used in fibromuscular hyperplasia of the renal artery. Autogenous saphenous vein is the graft material of choice; however, a Dacron prosthesis may also be used. The two drawings below demonstrate resection of the artery with end-to-end vein graft replacement.

TRANSPOSITION

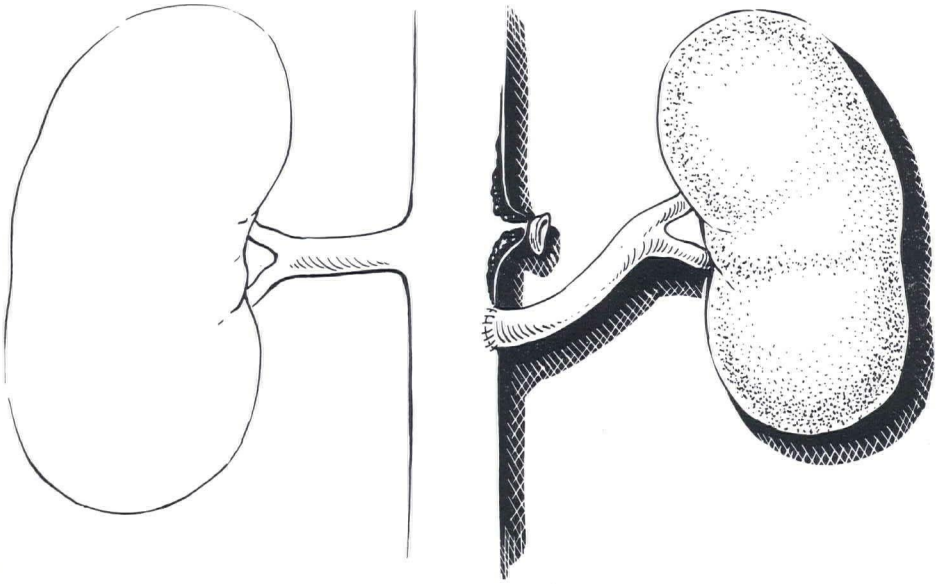

Figure 7

Transposition of the proximal left renal artery to a nondiseased area of the aorta is shown. This operation has limited usefulness as it is unusual for the aorta to be free enough from arteriosclerotic disease to allow renal revascularization in this manner.

SPLENO-RENAL ANASTOMOSIS

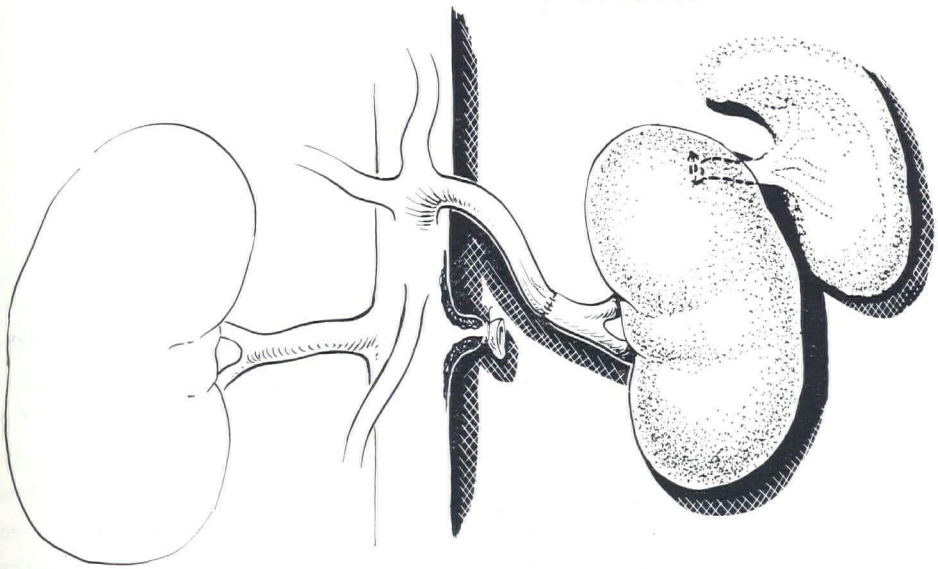

Figure 8

The technique of splenorenal arterial anastomosis is illustrated in this drawing. Following ligation of the left renal artery at its origin, an end-to-end anastomosis is made with the divided proximal splenic artery. The distal splenic artery is ligated. Removal of the spleen is unnecessary.

Overall Results

It is difficult to draw conclusions as to which type of operation was most successful. Of the nine patients who had endarterectomy, six improved, three were unimproved. Of the six having a bypass procedure, six were improved. Of the five who had transposition operations, four were improved and one remained unimproved. Both patients with the splenorenal anastomosis were improved and both of the patients with replacement operation were unimproved. Of six patients who had nephrectomy after unsuccessful repair, five were improved and one unimproved. The overall improvement (Table IV) of the 24 cases who had renal arterial reconstruction was improved 18 (75%), unimproved 6 (25%). When those with nephrectomy after unsuccessful repair are included, the total for the 30 cases was 23 (77%) improved and 7 (23%) unimproved.

Table IV

HYPERTENSION DUE TO RENAL ARTERY STENOSIS

1960 - 1965

# Cases	Operation	Improved	Unimproved
9	Endarterectomy	6	3
6	Bypass	6	
5	Transposition	4	1
2	Splenorenal	2	
2	Replacement		2
24	Total	18 (75%)	6 (25%)
6	Nephrectomy after unsuccessful repair	5	1
30	Total	23 (77%)	7 (23%)

Discussion

Many patients have hypertension associated with renal artery stenosis and many with atherosclerotic renal artery stenosis are normotensive.[6] We have selected only a few of these patients for operation to treat hypertension. In the majority of the patients with renal artery stenosis, medical treatment and nonrenal surgical procedures were used because either femoral, coronary, cerebral, aneurysmal or occlusive aorto-iliac disease was of primary importance, or hypertension was transient, or the hypertension was readily controlled with antihypertensive drugs. Only in very well selected cases was curative surgical treatment offered to conserve renal tissue and lower blood pressure. The only way that it can be conclusively proved that hypertension is due to renal artery stenosis is to bring about a return of the blood pressure to normal coincident with the reconstructive surgery which alleviates a renal artery stenosis.

Of many clues to diagnosis, the most rewarding were upper abdominal murmurs which were high-pitched, loud and continuous or systolic in time, specific abnormalities on rapid sequence intravenous pyelogram or radioisotope renogram and the abrupt onset of an established diastolic hypertension or rapid progression of pre-existent hypertension. Hypertension which began or became worse after back or flank pain suggested serious renal artery disease. The antecedent history of focal ischemia attacks affecting cerebral, coronary or peripheral arteries prior to development of high blood pressure also pointed to probable atherosclerotic renal arterial disease as a cause of the high blood pressure. The presence of the type of murmur described in a young woman with hypertension is almost pathognomonic for fibromuscular hyperplasia of the renal arteries. In no instance did we find a patient meriting surgical treatment who had both a normal isotope renogram and a normal intravenous pyelogram.

It is most enlightening to analyze our arteriographic findings in relation to success of operative approach as done elsewhere.[7] Of those patients who had only unilateral renal artery stenosis, six were cured and one improved. Of those with bilateral renal artery stenosis with operation on both sides, four were cured and one improved. Of those who had bilateral renal artery stenosis with operation only on one side, three were cured and eight improved. This data report refers only to those 23 cases who were either cured or improved. It emphasizes that the cure rate is higher when the renal artery stenosis involves only one main stem renal artery and that when bilateral operations are done for bilateral renal artery stenosis the cure rate is higher. Failure to get a cure in many cases may be due to persistence of uncorrected renal artery stenosis in the contralateral renal artery even though a successful procedure has been done on one side.

In conclusion, more than two thirds of patients with high grade stenosis of main stem renal arteries may be benefited by competent surgical treatment and, in our experience, at least one third of such patients may be cured of hypertension due to renal artery stenosis.

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