Renovascular hypertension: diagnosis and treatment

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RENOVASCULAR HYPERTENSION: DIAGNOSIS AND TREATMENT.
A SINGLE CASE PRESENTATION.

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Submitted in Partial Fulfillment for the Degree of
Doctor of Medicine

College of Medicine, University of Nebraska

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Omaha, Nebraska
(with class of 1964)
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INTRODUCTION

There has been a recent interest concerning the problem of hypertension based on renovascular etiology. At present it would appear that alteration of the renal artery or its major branches contributes to hypertension. Improvement of diagnostic techniques and surgical methods has resulted in good share of these patients being relieved of their hypertension.

It is the aim of this paper to briefly review the embryology and anatomy of the renal arteries and their major branches and to inspect more fully, methods of diagnosis, therapy, and prognosis of renovascular occlusive disease.

I. Embryology of Renal Artery.

In development, during the ascent of the kidney from the pelvis to adult position, the origin of renal arteries correspond to the degree of kidney ascent. Thus Areyl explains that the embryonic urogenital ridge in which the kidney develops is supplied by multiple paired vessels called the rete arteriosum urogenitale. With the development of the mesonephros, segmental paired arteries are seen to supply this organ and are derived from the abdominal aorta and iliac arteries. As development proceeds all but one pair of mesonephric arteries disappear. This single pair becomes the renal arteries of the metanephric kidneys. Variations of renal vascular supply do occur and are currently thought to be due to persistent mesonephric arteries.
II. Anatomy of Renal Artery.

Present day concepts of segmental arterial supply of the kidney are largely due to the work of Graves\(^2\) (1956). Sykes\(^3\)(1963) found the typical arterial supply in most cases reveals the renal artery to divide into two major branches and these in turn give rise to five segmental branches. It should be stated here that the division of the major branches may occur anywhere just proximal to or within the hilus of the kidney. Variations from the typical pattern exist. These are two in number and are termed (1) arterial pattern similar to the venous arrangement and (2) dual arterial pattern. The venous arrangement of arterial supply consists of a single renal artery dividing into three major branches and each of these branches supply their respective thirds both anteriorly and posteriorly. The dual pattern consist of two arteries from the aorta, each being comparable in diameter and entering the hilus adjacent to each other. These two arteries give rise to the five segmental branches similar to the typical arterial supply. Aberrant or accessory renal arteries occur in approximately 30% of necropsy studies by Anson, Richardson, and Minar (1940)\(^3\). Strictly applied, these are said to be persistent mesonephric arteries. An important consideration is the fact that these arteries enter the cortex either at the superior and inferior poles and are always end arteries without anastomosis.
III. Present Day Concept of the Cause of Hypertension of Renovascular Origin.

Goldblatt\(^4\) (1934) and colleagues developed a dependable method for the production of sustained hypertension in dogs. Following this, many investigators have tried to explain the biochemical mechanism of renal hypertension. At present, it appears that renal arterial narrowing may lead to hypertension by two mechanisms\(^5\); the first, the renin-angiotension theory whereby a vasopressor substance is released into the blood stream which in turn potentiates the response of arterioles to epinephrine. Recently, evidence have suggested that the kidney's role in renal hypertension may be its failure to excrete or to metabolize a circulating pressor substance similar to or identical with nor-epinephrine. However, revealing these dog experiments and chemical hypotheses may seem, clinical correlation may not always corroborate such academic concepts. Greenblatt\(^6\) (1963) has shown in his studies of selective necropsy of fifty kidneys by angiography that no objective criteria exists which permit the differentiation of hypertensive from normotensive individuals in the age group studied between 50 to 80. Both groups had arterial stenosis by atherosclerotic plaque formation and the severity of stenoses were distributed equally among the two groups.

No carefully controlled studies of the younger age group have been performed to date although historically, Ask-Upmark in 1929 reported five cases among young girls who at post mortem
examination had malignant nephrosclerosis and unilateral renal abnormalities. Butler in 1937 reported the diagnosis and cure of hypertension by unilateral nephrectomy in two pyelonephritic children. The first report of renovascular insufficiency causing hypertension was made by Leadbetter and Barkland7 in 1938. The patient was a 5½ year old hypertensive since age three who was cured by a nephrectomy on the involved side. Pathologically, the kidney was small and the renal artery narrowed by a lesion similar to fibromuscular hyperplasia as we know it today. Histological appearance of this kidney was normal. Other reports quickly followed and numerous type of lesions involving one kidney have been shown to be associated with systemic hypertension. The classification of diseases contributing to major, main branches, and accessory renal artery stenosis is given below. It should be emphasized that other diseases involving renal parenchyma such as pyelonephritis or hydronephrosis has been known to cause renal hypertension but this paper is primarily concerned with the renal vessels and the discussion will be limited to this aspect.

IV. Pathology.

Fibromuscular hyperplasia of the arterial wall is the usual cause of renal artery stenosis in patients less than 40 years of age. Atherosclerotic occlusion is the usual lesion found in older patients. Trauma to the renal artery, embolic occlusion, true aneurysm, and dissecting hematoma, can occur at any age.
Classification of Some Major Causes of Renal Arterial Stenosis.

1. Arteriosclerotic Plaques.
2. Fibromuscular Hyperplasia.
3. Congenital Hypoplastic or Anomalous Renal Artery.
4. Embolism in Renal Artery.
5. Syphilitic vascular disease of Renal Artery.
6. True or Dissecting Aneurysms.

V. Incidence of Unilateral Renal Disease Causing Hypertension and the Results of Surgery.

Only two to three percent of all patients with diastolic hypertension have clinical or laboratory evidence which raises suspicion of unilateral renal disease or bilateral arterial constriction. Only 20 percent of these have been subjected to surgical procedure via arterial repair or nephrectomy. Of these, 31 percent have been cured of their hypertension when cure is defined as a blood pressure below 140/90 for longer than one year. Another 25.9 percent have been classified as improved. Improved has been defined as diastolic pressure reduction to be between 90 and 100 mm. of mercury and being lower than their preoperative level. In view of the results of over 50 percent being cured or improved when the operations were completed primarily during a period of data collection, the incidence of cure or improvement should be higher during the next study period.
Table I reveals a recent series of studies by various investigators. No definite age group or sex incidence was given.

Table I.

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<th>No. subjected to surg.</th>
<th>No. cured</th>
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VI. Present Day Method for the Diagnosis of Renovascular Stenosis.

A. History and Physical Examination.

1. Onset of diastolic hypertension under age 30 or after age 55.

2. Sudden onset or sudden acceleration of hypertensive vascular disease in any person.

3. Diastolic hypertension associated with:
   a. History of trauma to kidney area.
   b. Presence of bruit over a kidney.
   c. History of embolic or thrombotic phenomena in other areas.

B. Screening Tests.

1. Intravenous Pyelography.
a. Asymmetrical filling of pelvicalyceal system at 1 to 3 minutes following contrast injection.

b. Asymmetry or shrinkage of kidney. A difference of 1.5 cm. or greater in length.

2. Radioactive Renogram (Radioactive Hippuran).

Time curves of each kidney show asymmetry.

C. Final Tests.

1. Renal Aortogram.

2. Howard Test.\textsuperscript{10,11}

   a. Urine flow differences of at least 50\% between catheterized ureters.

3. Sodium concentration in collected urine.

   a. A 15\% decrease in sodium concentration of affected side.

4. Urinary creatinine.

   a. Increase in creatinine concentration on involved side.

VII. Medical Treatment of Renal Hypertension.

Hypertension of renal artery occlusive disease responds to antihypertensive drugs similar to essential hypertension. Thus it becomes obvious that one should weigh seriously the mode of treatment of these patients. Gifford\textsuperscript{12} (1963) feels that medical treatment at best is tedious, expensive, and only palliative.
Side effects are often troublesome and the drop-out rate is high even in intelligent and cooperative patients. Poutasse\textsuperscript{13} feels that by eliminating poor risk patients, the mortality rates of operation by experienced surgeons are surprisingly low and more than 60 percent of the patients he operated on have normal diastolic pressure as long as six years after surgical intervention. He feels that medical treatment, even though effective, will not prevent the progressive conditions of atherosclerosis and fibrotic diseases of the renal artery which eventually result in ischemic atrophy. Thus, even though hypertension is not cured, the deterioration of kidney function is prevented by surgical correction. Fairbairn\textsuperscript{14} has emphasized that even though a renal vascular cause is suspected in the 60 to 70 year age group, he would treat these patients medically, and in the 40 to 60 year age group he would think several times before exposing the patient to extensive studies. In the less than 40 year age group and patients who do not respond to medical therapy, extensive workup and surgery is performed if indicated. Thus a wide range of treatment for renal hypertension exists today throughout different regions of the country.

VIII. Surgical Approach to Arterial Stenosis.\textsuperscript{13}

A. Nephrectomy - when arterial repair is not possible and in poor risk patients. Done when reconstructive or segmental resection have complicated.
B. Reconstructive procedure.

1. Simple resection of a small, focal lesion with end to end anastomosis of remaining renal artery. This is not possible when the lesion is extensive or is close to the origin of the renal artery (249).

2. Endarterectomy with removal of an atheromatous plaques, thrombosis or an area of fibrovascular hyperplasia.

3. Splenorenal anastomosis - anastomosis beyond area of constriction. Can be used for right or left kidney.

4. Bypass grafts - used for lesion near renal artery origin and for bilateral lesions. Synthetic dacron grafts are in most general use. This method is indicated by some in all practical situation.

5. Segmental Resection - when branch of renal artery is involved. Emphasis on preserving as much functional renal tissue as possible.

IX. Observation of Factors Leading to Success or Failure of Treatment.

In the analysis of factors leading to the success or failure of surgical treatment, a study of eventual surgical results should be made in relation to preoperative clinical data, the
results of diagnostic studies, the findings at surgery and the immediate postoperative course.

Baker and colleagues\textsuperscript{15} (1962) in an excellent study and follow up of 23 patients who have had surgery performed and followed from 12 to 36 months, found in their studies that intravenous pyelography and radioactive isotope renography proved to be good screening tests for the detection of renovascular disease. Arteriography was useful in delineating vascular lesions and in the planning of surgery. The Howard test proved the most accurate means of predicting the eventual outcome of surgery. Results of renal artery reconstruction were good when arteriography gave evidence of unilateral renal disease and when a pressure gradient of 60 mm. of mercury or more was demonstrated across a stenotic artery. They also found that the outcome of favorable results compared well with the degree of nephrosclerosis as determined by renal biopsy. An interesting finding was that patients who were classified as cured or improved a year or longer after surgery usually demonstrated a normal diastolic blood pressure on the third postoperative day.

X. Case Presentation.

A single case of renal hypertension is presented because of subsequent follow up of hypertensive status after one year observation.

A 50 year old housewife was admitted to Bishop Clarkson Memorial Hospital on May 14, 1962 for hypertension and diplopia
of ten days' duration. Except for tiredness and occasional sub-
occipital headaches which began two months ago, her general health
has been considered good and examination three and seven years
ago did not reveal a hypertension. Physical examination at this
time indicated a well nourished and well developed female with a
blood pressure of 210/120. Funduscopic examination showed marked
narrowing of arterioles bilaterally and left 6th nerve palsy. The
remaining systems were within normal limits. Intravenous pyelogram
revealed relative delay in dye appearance of right kidney at one
minute and equal dye concentration at ten minutes. A 2 cm.
difference in the size of the kidneys could be measured at this
time with the right being the smaller of the two. Radioactive
renogram suggested a pattern consistent with impaired vascular
supply to the right kidney. Renal transluar aortagram revealed
a narrowing of right renal artery. BUN was 21 mg.% and urinalysis
was negative. Remainder of the clinical laboratory examination
was within normal limits and the Howard test was not used.

On June 8, 1962, an operation was performed. Findings
were that of fibromuscular hyperplasia with stenosis and a re-
vascularization of right renal artery was attempted using a vein
graft. A blood pressure drop to 160/88 in the recovery room was
recorded. Postoperative course was uneventful except for the
disappearance of the previously described diplopia and the paresis
of left 6th nerve appear improved. She was discharged with a
pressure of 174/90.
She was readmitted on September 24, 1962 for a revaluation of renal vascular supply and renal function because of a recurrence of hypertension. At the time of admission her blood pressure was 210/103. On September 26, 1962, percutaneous retrograde renal aortogram revealed a stenotic segment of right renal artery just proximal to the previous renal artery vein graft. A faint nephrogram was suggested on a 20-minute delayed film study. A Howard test was done and the results indicated a 50 percent decrease of urine flow by the right collecting system as compared to the left. On October 4, 1962, a right nephrectomy was performed because of recurrence of stenosis distal and proximal to the by-pass vein graft and salvage of this kidney was not feasible. Again the blood pressure fell to 164/100 in the recovery room. Although the pressure climbed to as high as 244/114 on the second postoperative day, it gradually began to fall so that at the time of discharge, the pressure was 156/86. Followup studies after one year revealed a normotensive patient with normal eyegrounds and no evidence of diplopia.

XI. Discussion.

An interesting case of fibromuscular hyperplasia is presented in a 50 year old woman who developed hypertension after age 47. Both operations performed on this patient confirmed that her hypertension was the results of renal ischemia. Fibromuscular hyperplasia is usually found in patients below the age
of 35 although this was not true in this patient. Perhaps the entity should be further evaluated. Explanation at this time by this investigator is only theoretical and it may be that unilateral parenchymal disease may elicit a compensatory hypertrophy of intimal and muscular elements of the renal artery or their immediate branches. The fact that intimal proliferation and muscular hypertrophy recurred distal and proximal to the vein graft is not readily explained at this time.

Intravenous pyelogram and radioactive renogram were both positive for screening purposes in this patient. Although the one, two, and three minute films advocated by others have been widely used, 25 percent of proved cases of stenosis of renal artery gave negative pyelograms. Poutasse thinks careful interpretation of the radiogram has cut this error to 10 percent. Abnormalities to watch for suggesting occlusive disease of the renal arteries or its branches are:

1. Disparity in renal size (1.5 cm. or greater may be significant).

2. Compact calyces and pelvis on one side.

3. Diminished concentration of contrast medium on one side.

4. Static hyperconcentration of contrast medium on one side.

5. Non-visualization of one kidney.
6. Delayed appearance of contrast medium on one side.

7. Atrophy of one pole.

The radioactive hippuran test correlated well with the intravenous pyelogram in this patient. This test however is used primarily for screening purposes after the intravenous pyelogram reveals abnormalities suggesting renovascular occlusive disease. The test is not specific and renal parenchymal disease or hydrenephrosis will give positive results. Correct probe position and the patients state of hydration greatly influence the effectiveness of this test. It would appear that this test should not be performed if the intravenous pyelogram is interpreted as normal.

Renal angiography was the most effective means in the final diagnosis of renovascular narrowing in this patient. An actual narrowing by two ring-like constrictions could be demonstrated. The appearances of such constrictions are consistent with fibromuscular stenosis and were later verified by the pathological report. However clear cut this case seems to be, interpretation of a renal angiogram requires skill that comes only with experience. An occlusive lesion in secondary branches, narrow orifice without more distal changes, and complete occlusion of accessory renal arteries are conditions which most likely will escape detection. Careful attention should be given to peripheral vascularization of renal parenchyma for, in doubtful cases, poorly vascularized zones may be the only clue to occlusive lesions in minor branches or in non-visualized accessory arteries. The actual
technique of a renal aortogram performed today is via either translumbar aortography or percutaneous catheterization. Both appear effective and have their place in different situations. The recent discovery of the contrast medium angio-conray has greatly minimized complications and pain associated with rapid injection techniques.

A Howard test was done and was regarded as positive for right renal ischemia. Stamey, a strong advocate of the Howard test and criteria feels that this test alone is quite conclusive for renovascular ischemia. Poutasse and Gifford however disagree, stating that in branch occlusions, urinary flow may be decreased from the ischemic kidney but concentrations of sodium and other solutes are not usually altered. They also feel that a negative test results when bilateral occlusive disease of renal arteries exists. Furthermore, infection and prolonged pain are frequent complications so that in only selective cases where angiography is equivocal, a Howard test is performed. Leadbetter and workers, however, feel that the Howard test is most effective in predicting the prognosis of the operation.

A pressure differential across the stenotic area was not measured on this patient. In the future, such measurements should be used because Leadbetter and Poutasse both agree that a pressure difference of 60 mm. of mercury across a stenotic area predicts favorable postoperative results. The pressure differential can guide a surgeon in his choice of nephrectomy instead of
reparative procedure. Renal biopsy of parenchyma supplied by the stenosed vessel is indicated and the degree of nephrosclerosis may also aid the surgeon in his decision.

XII. Summary and Conclusion.

The recent problem of hypertension based on renovascular etiology has prompted re-examination of the embryology and anatomy of the renal artery and its major branches. The pathologic physiology of renal hypertension is based on two recent concepts. One being the renin-angiotensin theory and the other being the lack of an antipressor substance which ordinarily is produced in the kidney.

The etiology of renal artery stenosis is classified with atherosclerosis and fibromuscular hyperplasia being the most likely causes. The incidence of renal hypertension among essential hypertension cases is said to be approximately two or three percent. Twenty percent of these have been subjected to surgery and thirty one percent were cured and twenty five percent improved.

The diagnosis of renovascular disease relies on the history and physical examination, screening tests of intravenous pyelography and radioactive renogram and conclusive tests being renal aortography and the Howard test. It appears all these test should be performed at present even though a controversy exists.

Surgical treatment is indicated for renovascular stenosis over medical treatment unless cerebral or coronary arteriosclerotic disease as well as poor surgical risk patient contraindicates
surgery. Some factors suggesting success of operative repair are a positive Howard test and a pressure gradient of approximately 60 mm. of mercury across the stenosed vessel. A renal biopsy may also guide a surgeon in evaluating the degree of nephrosclerosis present.

A single patient was followed at Bishop Clarkson Memorial Hospital with hypertension, diplopia and sixth nerve palsy. All tests performed were positive between two interval operations. The pathological report, fibromuscular hyperplasia, was not ordinarily found in this age group. Further histopathological studies appear indicated. Followup studies after one year revealed a normotensive patient with normal eyegrounds and no evidence of diplopia or sixth nerve palsy.
XIII. Bibliography


