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THE RADIOLOGY OF THE ISCHAEMIC KIDNEY IN HYPERTENSIVE DISEASE

M. DENNY, *Lister Buildings, Johannesburg*

The spate of articles in recent literature on the use of angiography in the diagnosis of ischaemic renal disease bears eloquent testimony to the value of this examination. I presented to my physician colleagues a review of this technique and its results at their Congress held in Durban in July 1962,[1] and it is my hope that that review, and the present article, will serve to stimulate a more energetic approach to the problem by an increased demand for this rewarding procedure.

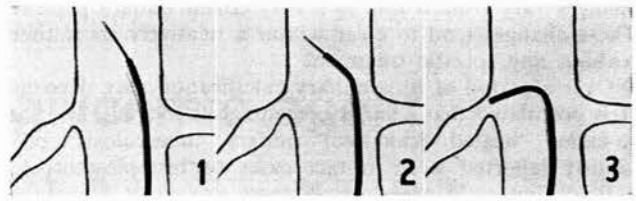
The following refinements in technique have produced an extremely safe and accurate method of diagnosis:

1. *The abandonment of the translumbar technique* except in those cases with absent femoral pulses. It is surprising that Brukin[2] still mentions its use in renal studies, and it is to be hoped that this is merely a reflection of American literature and not a method in current use by this author. It is encouraging to note that even in the USA there is a tendency, now, to employ the femoral approach instead of the lumbar technique, even though in some instances it is by arteriotomy and not by the percutaneous approach.[3]

2. *The use of hypotensive anaesthesia.* Halothane anaesthesia was first used for this purpose in the Johannesburg unit about 3 years ago by Dr. C. van Hasselt, and it was found that only in an insignificant number of cases was it necessary to use an intravenous 'arfonad' drip to obtain the desired effect. When, under halothane, the systolic pressure has dropped to half the pre-anaesthetic level, the arteriographic injection is undertaken, and the halothane is discontinued, allowing a rapid rise of blood pressure to near the pre-anaesthetic level. The objection that hypotension may predispose to coronary ischaemia proves not to be well founded, probably because the episode of hypotension is but transient.

3. *The use of the pressure pump.* This is essential, and the need has been adequately met by the relatively inexpensive Somerville pump. A pressure of 45 - 50 lb. per square inch is sufficient, if the 50-ml. syringe is used. Should this pressure be exceeded, the 205 polythene catheter is liable to rupture, fortunately at its proximal end.

4. *The abandonment of the use of the opaque Odman-Ledin catheter* for selective arteriography. Its use has been discontinued since Seldingen[4] pointed out to me that the 205 polythene catheter retained a preformed curve at blood temperature (Figs. 1 - 3).



Figs. 1 - 3. Diagrammatic demonstration of catheterization of renal artery with 205 polythene catheter.

We therefore introduce this catheter into the aorta by Seldinger's technique,[5] and opacify it by injecting a small quantity of 'urografin'. The catheter position is then ascertained by use of a 9-inch amplifier, which indicates whether the curved catheter tip lies freely in the aorta, or has engaged one of the vessels arising from it. In the latter case the catheter is manipulated until it lies within the aortic lumen, above the level of the second lumbar vertebra. 'Scoline' is then administered to the patient and on cessation of voluntary respiration the main injection is given, when a half-second exposure is used with a 1-mm. focus. Three films are exposed, with the use of the conventional Bucky tray. The first film serves to identify the arterial pattern and the latter two, the nephrographic phases. There is no need for high-speed serial radiography, and the use of the Bucky, producing one film showing arterial phases of high detail, is indeed preferable to numerous high-speed films with possibly rather indifferent detail.

Subsequent pyelographic films are then exposed at 5 - 10 minute intervals.

When this method is used, in the rare * event of failure to

* Rare, at any rate, in our experience.

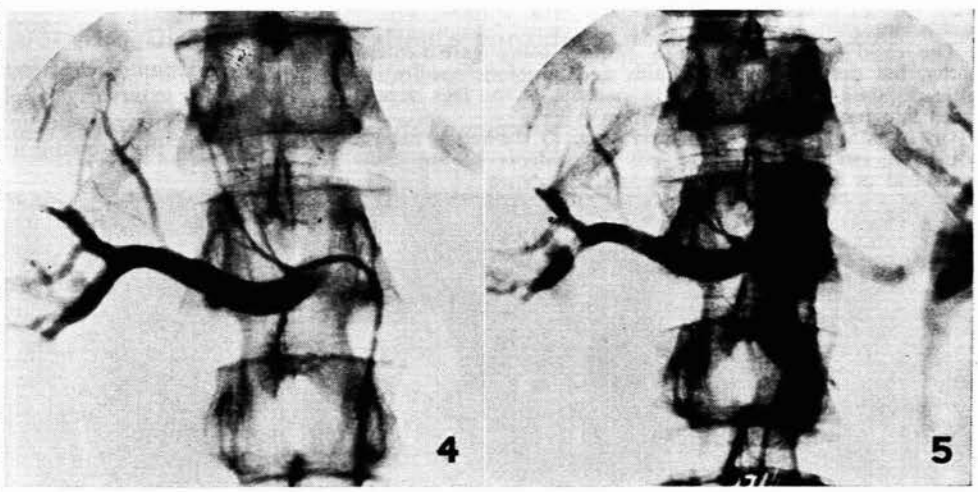


Fig. 4. Selective catheterization. The catheter tip has entered the artery and its origin is not shown.
Fig. 5. Same case as in Fig. 4. Catheter withdrawn slightly and origin of artery now shown.

fill one or other renal artery, the catheter is opacified and, with the aid of the image amplifier and closed-circuit television, the tip is then manipulated into the renal artery. I have found that it is advisable to withdraw the tip slightly, so as to allow the catheter to lie across the angle subtended by the inferior margin of the renal artery and the aorta (Figs. 1 - 6). This allows opacification not only of the renal artery, but of the adjacent aorta, thus precluding the possibility of missing a stenosis of the origin of the renal artery, which is often found in atherosclerosis.

Pressure Gradients

If recording equipment is available, confirmatory gradients across the stenosis can sometimes be obtained. If the stenosis is proximal, the catheter tip will pass across the narrowing, and on withdrawal the desired tracing can be obtained. Should the narrowing be more distal, further

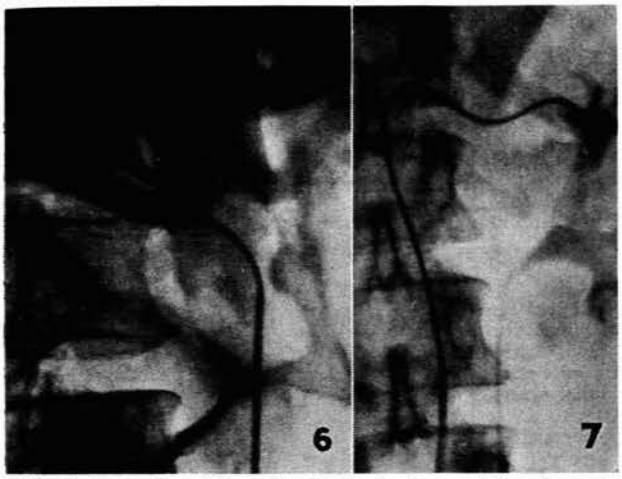


Fig. 6. Correct position of catheter to show origin of renal artery.

Fig. 7. Seldinger guide wire No. 160 inserted to renal hilum to serve as a guide to polythene catheter.

insertion of the polythene catheter, depending on the configuration of the artery, may have the result that the catheter buckles and disengages itself from the artery. It then lies free in the aortic lumen. On occasions insertion of the 160 Seldinger wire, until it reaches the hilum, will guide the catheter to the distal reaches of the vessel (Fig. 7). The wire is then withdrawn to be followed by the catheter now on pressure.

Stewart *et al.*[3] state that any gradient over 20 mm. requires operation, and under 10 not. However, they quote contradictory results in operations based on these criteria, which tend to negate the value of the procedure.

We have rarely used this method, because in most cases the radiological studies have proved conclusive.

Intravenous Pyelography

In our own practice we do not advocate initial pyelography. This is a sharp break from tradition, but we feel that there are cogent reasons for it. They are the following:

1. We have frequently found marked degrees of stenosis in the presence of normal pyelographic findings (Figs. 8 and 9).

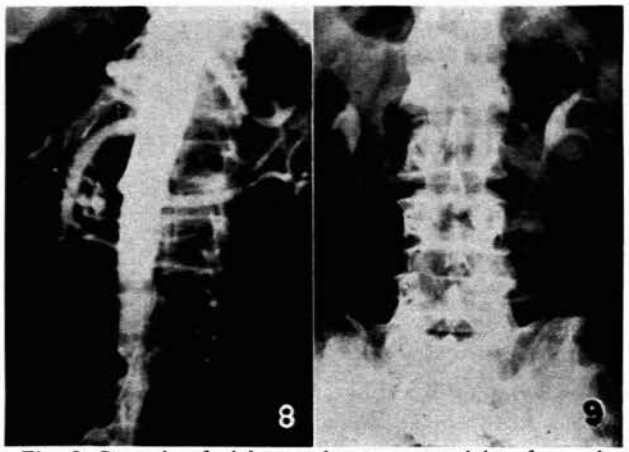


Fig. 8. Stenosis of right renal artery at origin of vessel.
Fig. 9. Same case as in Fig. 8, showing normal pyelogram.

2. The safety of first-stage arteriography has been adequately proved. Since our unit has used the method described, no mortality or complications have ensued. It may be pertinent to mention that flank pain after the examination is usually caused by the scoline administered, and not by the instrumentation. It is unassociated with other symptoms and is transient in nature.

3. In private practice the cost to the patient is drastically reduced by the single combined examination.

These considerations do not of course entirely negate the value of initial pyelography, for in cases such as the following much suggestive information is gained by this procedure:

1. Hyperconcentration under conditions of water loading is suggestive of an ischaemic kidney. This, however, may also occur in pyelonephritis.

2. Isolated or slight general dilatation of the calyceal system.

3. Foreshortening and slight compression of a calyx. This is associated with localized infarction and is presumably due to parenchymal oedema in the infarcted area.

4. Delayed appearance of contrast medium in the affected kidney. The margins of such a kidney are usually smooth, as opposed to the lobulation of the congenitally atrophic contracted kidney. The pyelonephritic contracted kidney, on the other hand, has a scarred serrated margin. These differentiating features have been well described by Munk *et al.*[6]

6. Failure of the kidney to excrete contrast medium. This may be found in sudden thrombosis associated with the Leriche syndrome or aneurysms of the renal artery.

7. Crenation and indentation of the renal pelvis and calyces due to collaterals.[7,8]

The Incidence of Renal Ischaemia

Table I indicates the percentage of cases of ischaemic kidney found among patients referred for examination by this procedure as reported by different radiologists. The most reliable figures are probably those from the large series of Dustan[9] in the USA (27%), and Sutton[10] in the UK (10%). Our own figures show an initial inci-

dence of 8 cases out of 30 examined (27%) in 1960[11] and 8 cases out of 50 (16%) in a more recent series. The different percentages in Table I cannot be used for statistical comparisons. They do indicate, however, that the incidence is higher than originally thought and, since the results of modern surgery are so satisfactory, it would seem that more attention should be paid to accurate diagnosis in this condition.

TABLE I. RENAL ISCHAEMIA (COMPARATIVE SERIES)

Author	*Year*	*No. of cases*	*% ischaemic*
Dustan *et al.*[9]	1959	317	27
Sutton *et al.*[10]	1961	260	10
Halpern *et al.*[14]	1961	41	49
Moser and Caldwell[13]	1962	50	66
Denny[11]	1960	30	27
Denny	1962	50	16

Our last 50 cases

Table II gives an indication of the various lesions found in our last 50 cases. Of interest perhaps is the preponderance of aberrant renal artery on the right side, especially in male subjects. Possibly due to a more critical selection is the low incidence of 3 cases of pyelonephritis out of 50 as opposed to 5 out of 30 in the previous series. About twice as many males were referred for the investigation as females (34:16). The age range was considerable (from 17 to 69 years), which is one reason which seems to suggest that the criteria for this investigation should not be limited to those generally accepted. The newly described fibromuscular hyperplasia (Figs. 12 and 13), also, does not seem to have any clearly defined clinical pattern, apart from its preponderance in females, and the frequent presence of a bruit.

TABLE II. RENAL ISCHAEMIA. LESIONS FOUND IN 50 CASES EXAMINED BY ARTERIOGRAPHY

Diagnosis	*No. of cases*		
	Male	*Female*	*Total*
Ischaemic kidney	5	3	8(16%)
Pyelonephritis	1	2	3(6%)
Aberrant renal arteries			
Right side	10	3	13(26%)
Left side	0	2	2(4%)
Total	10	5	15(30%)
Secondary hypertensive change in renal arteries	1	2	3(6%)
No apparent disease	17	4	21(42%)

No. of cases 50—males 34 (68%), females 16 (32%)
Age range 17 - 69 years.

It is of interest to note the sloping angle of the renal artery and the predominant involvement of the right side in our cases (Tables II and III).

Secondary hypertensive change, without stenosis, is occasionally seen and is associated with similar change in other splanchnic vessels. The aetiology of the primary hypertension in such cases is often obscure, but fortunately the incidence of this appearance is less than that of correctable ischaemic disease. At this point attention may be drawn to the occasional detection of significant stenosis of the renal artery with no associated hypertension. Figs. 10 and 11 illustrate a case observed in our own series.

TABLE III. NATURE OF ISCHAEMIA-PRODUCING LESIONS, ETC., IN THE 8 CASES OF ISCHAEMIC KIDNEY IN TABLE II

Ischaemia-producing lesion	*Treatment*	*Result*	*Age*	*Sex*
Fibromuscular hypertrophy	Medical	Good	48	F
Polycystic kidney	Decompression cysts	Good	30	F
Hydronephrosis	Nephrectomy	Good	33	F
Atherosclerosis R. renal artery	Nephrectomy	Good	52	M
Leriche occlusion R. renal artery	Medical	No change	48	M
Atherosclerosis L. renal artery	Medical	Died	42	M
Arteritis & stenosis aberrant R. renal artery	Nephrectomy	Good	38	M
Atherosclerosis main R. renal artery	Medical	Controlled	69	M

Table III illustrates the nature of the ischaemia-producing lesions in the 8 cases of our last series. Kottler[12] (1962) presented an incidence of 'renal arterial pathology' in 34% of hypertensive cases. This rather high incidence, as in our first series, probably indicates that a disproportionate number of cases were drawn from the pool of refractory hypertensives. Since the examination is gaining

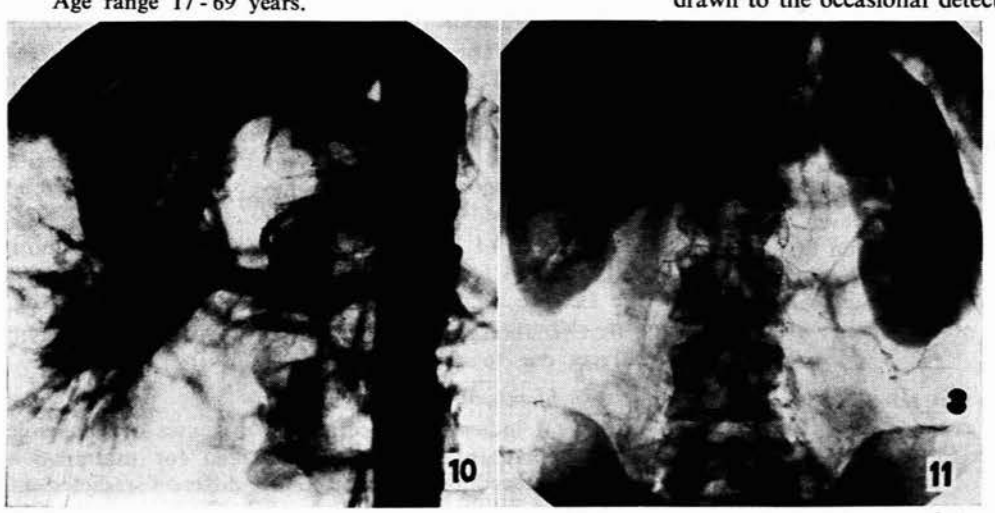


Fig. 10. Atherosclerotic narrowing of origin of right renal artery in a normotensive subject.
Fig. 11. Same case as in Fig. 10 showing contracted right kidney.

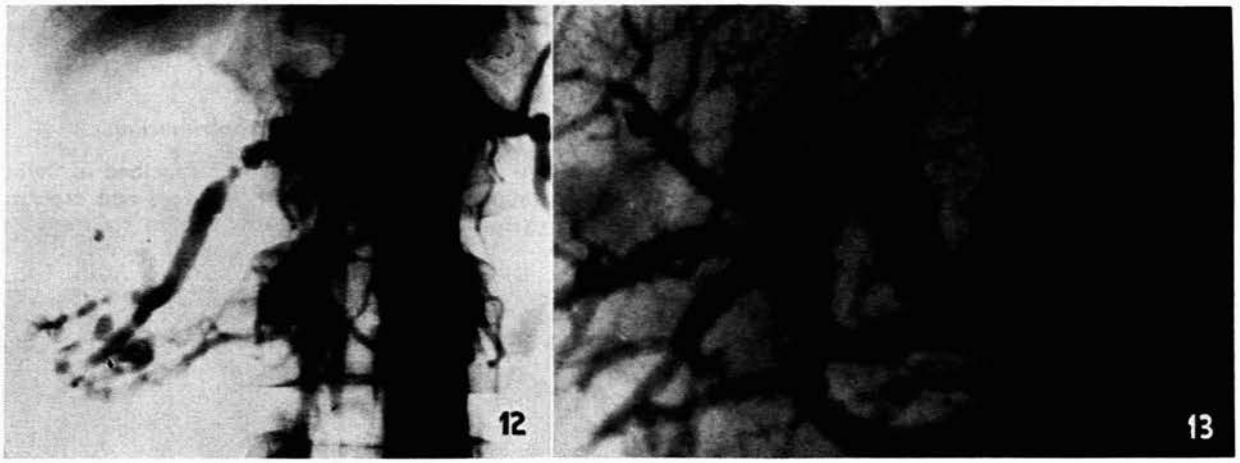


Fig. 12. Fibromuscular hyperplasia of right renal artery with marked stenosis. Minor changes involve the left. (Dr. R. Saner.)
Fig. 13. Same case as in Fig. 12. Nylon graft from aorta to renal artery beyond stenosis. Note atrophy of original renal artery. (Mr. P. Theron and Mr. J. Jordaan.)

popularity it is to be expected that for some time a relatively high incidence will be reported. There appear to be many factors governing the percentage incidence, an example being the critical selection cited by Moser and Caldwell[13] in 1962. It is, however, my belief that the calculated incidence based on radiological diagnosis will tend to fall, and probably will become stable at a figure between 10 and 15% once the procedure becomes routine in the investigation of hypertensive disease.

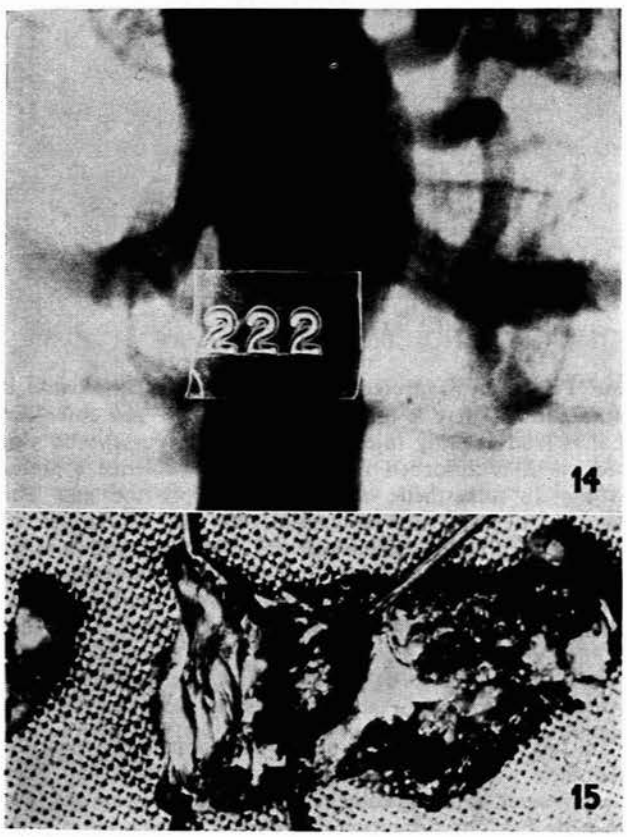


Fig. 14. Bilateral coarctation of the renal arteries in a case of fibromuscular hyperplasia.

Fig. 15. Ribbing of intima of renal artery involved in fibromuscular hyperplasia; thrombi are also present.

Fibromuscular Hyperplasia

The value of arteriography is amply illustrated in Fig. 12, where a marked fibromuscular hyperplasia was demonstrated in a female in whom normal results were obtained on pyelographic study, and no bruit was to be heard. Dramatic relief followed the insertion of a nylon bypass from the aorta to the artery distal to the stenosis (Fig. 13).

Bilateral coarctation of the renal arteries in a male patient aged 38 is clearly illustrated in Fig. 14. A resected renal artery showing the appearance of ribbing of the intima of the artery in a case of fibromuscular hyperplasia is shown in Fig. 15.

SUMMARY

Stenosis of the renal artery is a not uncommon cause of hypertension. The author gives reasons for his opinion that renal angiography by the method described in the article is a safe and valuable procedure, probably exceeding any other single diagnostic examination in merit. It would appear that few surgeons, if indeed any, would be prepared to undertake corrective surgery without the benefit of this investigation.

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