RATIONAL IMAGING

Investigating progressive unexplained renal impairment and hypertension

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Diagnosing renal artery stenosis can be difficult. This article explores possible types of imaging for this, ranging from safe, inexpensive tests to more invasive procedures

The patient

A 79 year old hypertensive man was referred for investigation of impaired renal function. At the time of referral he was taking a single antihypertensive agent and his blood pressure measured 170/85 mm Hg. He smoked 50 g of pipe tobacco a week. He had no other medical history of note. No renal artery bruit was detected, and the remaining clinical examination was unremarkable. His serum creatinine concentration at presentation was 116 mmol/l (normal range 60-110 mmol/l), representing an estimated glomerular filtration rate of 55 ml/min. Urine analysis was normal. His serum cholesterol concentration was raised (5.9 mmol/l (normal range 3.0-5.2 mmol/l). Over two years, his blood pressure remained raised despite an increase in his antihypertensive treatment, and his serum creatinine concentration rose to 206 mmol/l.

What is the next investigation?

Unexplained, progressive renal impairment, and hypertension that is poorly controlled despite the use of multiple drugs, warrants further investigation. The absence of blood and protein in the urine points away from intrinsic renal disease. Both a prerenal cause (such as renal artery stenosis) and obstructive uropathy are possible diagnoses. Renal artery stenosis is an important diagnosis to make as it is common, potentially treatable, and associated with a higher mortality from end stage renal failure than other causes.^{1 2}

Ultrasonography

Ultrasonography is the usual first investigation as it is safe, inexpensive, and widely available. Obstruction is generally easily detected, but occasionally a calculus causing intermittent obstruction may be missed. Size difference of >1.5 cm or a solitary

LEARNING POINTS

Renal artery stenosis is a common condition in elderly people presenting with renal impairment and hypertension. Ultrasonography is the first line method of imaging as it is safe, inexpensive, and widely available and readily detects obstructive causes. However, a normal renal ultrasound study does not exclude the diagnosis of renal artery stenosis.

Magnetic resonance angiography and computed tomography angiography are the preferred non-invasive imaging methods to identify renal artery stenosis. Digital subtraction angiography should be reserved for patients in whom endovascular intervention is being considered or when non-invasive imaging is inconclusive.

kidney are the potential ultrasound features of significance in renal artery stenosis. Doppler studies are conducted for renal artery evaluation in some centres. The reported sensitivity ranges from 60% to 97%, and specificity from 85% to 99%,³ but the results are highly dependent on operator expertise, and interpretation is consistently accurate only in non-atheromatous arteries. Visualisation is limited by adipose tissue and bowel gas; accessory renal arteries may be missed; and mild stenosis is difficult to detect. Given the technical difficulties and time consuming nature, Doppler studies may be replaced by other, non-invasive methods of imaging the renal arteries.

Nuclear medicine

Conventional ^{99m}technetium-mercaptoacetyl triglycine (^{99m}Tc-MAG3) renography allows evaluation of the split function of the kidneys (contribution of each kidney to overall function) and exclusion of functional obstruction by assessing renal excretion and drainage. In the absence of obstruction, a difference in split function may be indirect evidence of renal artery stenosis. The use of an angiotensin converting enzyme inhibitor in conjunction with renography (captopril challenge scintigraphy) removes angiotensin II mediated vasoconstriction, which increases the difference in glomerular filtration rates of the stenotic kidney and the contralateral kidney. Sensitivities of captopril renography have been reported at 90%, with specificity of 79%.⁴ A

This series provides an update on the best use of different imaging methods for common or important clinical presentations. The series advisers are Fergus Gleeson, consultant radiologist, Churchill Hospital, Oxford, and Kamini Patel, consultant radiologist, Homerton University Hospital, London

Fig 1 | Conventional radionuclide renogram showing difference in split function with 69.3% of the total renal function arising from the left kidney and 30.7% from the right kidney

positive scan indicates the presence of renovascular hypertension with a haemodynamically significant renal artery stenosis. False negatives arise in the presence of bilateral stenosis, overhydration, and chronic use of angiotensin converting enzyme inhibitors, and impaired renal function reduces the specificity of the examination. Owing to these limitations, renography is not widely used for non-invasive diagnosis of renal artery stenosis.

Computed tomography angiography

Non-contrast enhanced computed tomography may show a small calculus not seen by other methods if the history is suggestive. The introduction of multislice computed tomography with the possibilities of three dimensional reconstruction has made computed tomography angiography an important non-invasive means of identifying renal artery stenosis. Image interpretation may be difficult in heavily calcified arteries.

However, computed tomography angiography involves the use of ionising radiation and iodinated

contrast medium. The procedure is therefore contraindicated in patients with contrast allergy and may not be tolerated by claustrophobic patients. The use of contrast in those with impaired renal function can result in contrast induced nephropathy. The most effective means of preventing this is by prior hydration. The use of various pharmacoprophylaxis agents and the benefits of iso-osmolar radiographic contrast agents remain controversial, with more evidence required. Computed tomography angiography is reported to have sensitivities of 90-98% and specificities of 85-94%.³

Magnetic resonance angiography

Magnetic resonance angiography has similar diagnostic accuracy to computed tomography angiography, with reported sensitivities of 90-100% and specificities of 88-100%.³ Comparable information is obtained about the number of renal arteries, the size of the kidneys, and the presence of anatomical variants. It has the benefits of producing angiograms without using iodinated contrast or radiation. Enhancement with gadolinium based contrast has generally replaced non-contrast enhanced techniques, but contrast associated nephrogenic systemic fibrosis in patients with moderate to end stage renal failure has been reported.⁵ (For further information visit www.mhra.gov.uk.) Contraindications to magnetic resonance imaging include use in patients with implants such as pacemakers, defibrillators, cochlear implants, and spinal cord stimulators. Claustrophobic patients should also be excluded.

Digital subtraction angiography

Arteriography with digital subtraction improves contrast resolution by removing background information. It is an invasive technique, carrying a small but definite risk that is related to the arterial puncture and to the manipulation of the catheter and wire. Although angiography uses iodinated contrast and entails radiation, carbon dioxide may be used as a non-nephrotoxic contrast agent in patients with renal impairment or contrast allergy. Pressure gradients can be measured across areas of stenosis to determine haemodynamic significance where there is doubt, and therapeutic procedures such as percutaneous transluminal angioplasty or stenting can be carried out at the same time, although how much such an intervention improves renal function is the subject of ongoing trials.

Outcome

Our patient had an ultrasound scan, which showed normal sized kidneys. As creatinine concentration improved and then deteriorated, ^{99m}Tc-MAG3 renography was conducted to look for functional obstruction. The renogram showed asymmetric function. As 69% of the overall function was from the left kidney, this raised the suspicion of underlying renal artery stenosis on the right (fig 1).

Fig 2 | Magnetic imaging angiography showing bilateral renal artery stenosis (arrows)

Fig 3 | Carbon dioxide angiography showing bilateral renal artery stenosis (arrows). A negative contrast agent (carbon dioxide) is used for the diagnostic study in patients with impaired renal function to minimise the iodinated contrast load and possible nephrotoxicity

Fig 4 | Position of stent across stenosis at origin of left renal artery confirmed with iodinated contrast medium angiography prior to release of the stent from its delivery mechanism (arrow). As precise placement of the stent is required, a positive (iodinated) contrast medium is used for the intervention study

Magnetic resonance angiography showed single renal arteries bilaterally with bilateral stenoses and a slightly smaller right kidney (fig 2). Our patient was encouraged to stop smoking and was started on simvastatin as his cholesterol concentration remained raised.

A year later, his serum creatinine concentration had increased from 116 mmol/l to 206 mmol/l and his blood pressure remained difficult to control despite an increase in his antihypertensive treatment. In view of the rising creatinine concentration, a decision was made to proceed to angioplasty and stenting in an attempt to preserve his renal function (figs 3, 4 and 5). The left renal artery was stented, but a guidewire could not be passed across the tight stenosis in the right renal artery. His serum creatinine concentration fell from 206 mmol/l to 163 mmol/l. His blood pressure improved from 170/85 mm Hg to 130/58 mm Hg with no change in medication.

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Fig 5 | Satisfactory position of stent confirmed post deployment (arrow)

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Doctor only to the dead

I worked as a clinical skills assessor in a research project in Nepal. Apart from seeing the health situation in rural Nepal, I heard dozens of stories about their work from the mid-level healthcare workers who had come to be assessed.

One of them said that in his area patients do not get an opportunity to see a doctor as “only the dead can see doctors.” I asked why that was, and he replied, “As you know, in Nepal the doctors are not available in villages. The mid-level healthcare workers like me, who have 18 months of medical training, are the ones responsible for most health care. We do almost anything—like the GPs

in the developed world. We prescribe medicine, perform procedures, even do minor surgery and conduct deliveries.

“But we are not authorised to do a postmortem examination. At that time a doctor (the only authorised service provider) is needed to write a postmortem report. They have to come from the district headquarters or even the zonal hospital, which is days’ walk from most villages. So we have the saying that ‘only dead people can see doctors.’”

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