American College of Cardiology
Position Statement

Radionuclide Scintirenography in the Evaluation of Patients With Hypertension*

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Purpose

Although studies obtained during the 1970s suggested that simple radionuclide scintirenography offered levels of sensitivity and specificity not different from those of intravenous urography, recent reports indicate that the addition of an angiotensin-converting enzyme (ACE) inhibitor magnifies the difference in function between the kidneys in the presence of functionally significant vascular stenosis. In several series of patients undergoing arteriography, ACE inhibitor scintirenography provides a very high degree of sensitivity.

The predictive accuracy of radionuclide scintirenography may be enhanced by selecting hypertensive patients with a higher likelihood of the disease, e.g., young patients, especially female, with a bruit over the kidneys (likely to have fibromuscular dysplasia); patients with an acceleration of previously eeasilycontrolled hypertension; patients with other evidence of occlusive atherosclerotic disease, heavy tobacco use or resistant

hypertension; patients with established hypertension and an otherwise unexplained decline in renal function; patients with continuous bruits over the kidneys; patients found to have irregularly shaped or small kidneys (especially unilateral), and new or more severe renal failure while receiving an ACE inhibitor. Radionuclide scintirenography also may be employed when known renovascular disease is treated medically and after renal revascularization procedures to ascertain sequential changes in symmetry of perfusion attributable to vascular stenosis and localized abnormalities such as small vessel infarction.

ACE Inhibitor Scintirenography

Radionuclide study of the renovascular bed combined with the physiologic challenge of ACE inhibition (e.g., by oral captopril or intravenous enalaprilat) is a useful test in the evaluation of the patient in whom the diagnosis of renovascular hypertension is being considered. Short-term ACE inhibition acts as a pharmacologic probe to evaluate the patient's renin-angiotensin-aldosterone system. In brief, when renal perfusion pressure is reduced (as in states of preglomerular stenosis), the transcapillary forces driving glomerular filtration are maintained by an angiotensin-II dependent vasoconstriction of the efferent arteriole. When this angiotensin-II-dependent vasoconstriction is removed after therapy with ACE inhibition, glomerular filtration (and urinary flow) of the kidney distal to the stenosis decreases. This reduction in ipsilateral renal function can be assessed noninvasively with radionuclide scintirenography.

To perform the study, most commonly captopril (25 or 50 mg*) is given orally 1 h before performance of conventional radionuclide studies. Angiotensin-converting enzyme inhibitors are best withheld for 2 to 5 days before the test to reduce the possibility of a false negative result that may be seen with long-term ACE inhibition. Intravenous enalaprilat in place of oral captopril has also been used in some centers because of a more rapid onset of action. In some studies, furosemide has been given along with the captopril to reduce false positive test results due to pelvic retention of radionuclide. Administration of other antihypertensive drugs may be continued. The patient should be adequately hydrated, particularly if diuretics are being administered, and the blood pressure should be monitored frequently. If desired, plasma renin may be sampled before and after captopril administration to complete a captopril-plasma renin activity test in addition to scintirenography.

*No data are available to support the choice of dosage.

Technique

Current radionuclide scintirenography provides sequential images of the distribution of radioactivity in the kidney during a period of at least 20 and preferably 30 min and the generation

of time-activity curves over each kidney to demonstrate in a semiquantitative manner the relative uptake and excretion of the radionuclide. The two modalities are evaluated in a complementary fashion. The radiopharmaceuticals most commonly available for performance of renal radionuclide studies include technetium-99m DTPA (excreted by glomerular filtration), hippuran I-131 (excreted by combined tubular secretion and glomerular filtration), and technetium-99m mercaptosuccinylglycylglycylglycine (MAG3) (excreted almost solely by tubular secretion). Currently available data do not support a distinction between technetium-99m DTPA and technetium-99m MAG3 in terms of relative sensitivity and specificity. Regardless of which agent is used, the interpretation of the study is similar.

Interpretation

Images should be obtained at 2- to 3-min intervals and are evaluated for relative uptake, size and shape of the kidney and the presence or absence of abnormalities in transit from the renal cortex to the renal pelvis and bladder. Interpretation of the images facilitates the detection of parenchymal renal disease and delays in transport from the renal pelvis which, particularly when associated with the administration of captopril, may lead to false positive interpretations (see later). Evaluation of the images is performed qualitatively.

The major variables evaluated from the time-activity curves are the uptake of each kidney at ≈1 to 2 min in relation to total renal uptake; time to reach the peak activity, and the amount of activity remaining in the kidney at 20 or 30 min in relation to the peak activity. Abnormalities suggestive of renovascular hypertension are a decrease in the relative uptake (the normal difference is 45% to 55%), a prolongation of the time to reach peak activity (the normal value is ~3 to 6 min) and an increased ratio of the activity at 20 or 30 min to the peak activity (the normal value depends on the specific technique used and should be determined for each institution). Qualitative changes suggestive of renovascular hypertension after administration of an ACE inhibitor are a change in the time-activity curve--that is, a decreased rate of uptake of isotope by the kidney, a lower and prolonged peak activity and a slower washout from the kidney. In evaluating the slower washout, retention in the renal pelvis must be excluded. Although immediately after injection it is possible to obtain very rapid images that provide a crude estimate of renal perfusion, this technique has not been shown to enhance interpretation and probably adds little to the accuracy of the test.

Although change or deterioration of the renogram of an individual kidney after captopril challenge is the hallmark of hemodynamically significant renal artery stenosis, a normal renogram after captopril administration makes the presence of hemodynamically significant renal artery stenosis unlikely. When the scintirenogram is abnormal and unchanged after short-term administration of an ACE inhibitor--that is, there is a fixed abnormality--parenchymal disease is most likely. However, in the presence of azotemia (creatinine >2.0 mg/dl), severe unilateral renal artery stenosis or bilateral renal artery stenosis, a lack of change after administration of an ACE inhibitor

may not rule out hemodynamically important renal artery stenoses (although the scintirenogram is almost always abnormal).

Although the change in the scintirenogram after administration of an ACE inhibitor is the most diagnostic indicator of renal artery stenosis, many centers perform the ACE inhibitor-stimulated scintirenography without first obtaining a baseline study. If the ACE inhibitor-stimulated radionuclide study is abnormal, a subsequent baseline study without an ACE inhibitor should be obtained for comparative purposes. Alternatively, the clinician may wish to forgo the baseline renogram and proceed directly to renal angiography if the clinical index of suspicion of renovascular hypertension is high.

Conclusions

Angiotensin-converting enzyme inhibitor radionuclide scintirenography provides a sensitive, noninvasive examination for hemodynamically important renovascular disease. It should not be applied as a universal screening test but can reasonably exclude or direct further studies in patient groups at high risk for renovascular disease.

Suggested Reading

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