Residents' Clinic

23-Year-Old Man With Hypertension and Flank Trauma

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A 23-year-old man presented with a 3-year history of untreated hypertension. He was an accomplished horse rider who had fallen several times during his teenage years. Three years earlier, he sustained an injury to the left flank while playing college football, with subsequent flank pain, ecchymoses, and a systolic blood pressure level between 150 and 170 mm Hg. He sought evaluation for blood pressure management. The patient denied having headaches, hematuria, weight change, dyspnea, chest pains, flushing, or decreased libido. This young man used no tobacco, nonsteroidal anti-inflammatory drugs, illicit drugs, or alcohol. His family history was unremarkable for hypertension.

Physical examination revealed a healthy-looking man in no distress. His blood pressure level was 170/110 mm Hg in each arm, his heart rate was 68 beats/min, and he was afebrile. Cardiovascular examination findings were normal. The lungs sounded clear bilaterally, the abdomen was without bruits or masses, lower extremity pulses were symmetrical with no pulse lag, and the funduscopic examination findings were normal. The initial laboratory test results are shown in Table 1. Chest radiographic findings were normal without rib notching, and an electrocardiogram suggested no left ventricular hypertrophy.

1. ***Which <u>one</u> of the following is the <u>most likely</u> cause for this patient's hypertension?***

a. Essential hypertension
b. Primary aldosteronism
c. Pheochromocytoma
d. Coarctation of the aorta
e. Renal disease

Essential hypertension accounts for 89% to 94%[1-3] of all hypertension seen in clinical practice. This form of hypertension tends to present in middle-aged individuals who are usually asymptomatic with normal physical examination and laboratory tests but with concurrent cardiovascular risk factors such as family history, diabetes mellitus, smoking, and obesity. Approximately 5% to 7% of patients do not fit this profile; such patients should be examined for secondary causes of hypertension after causes such as nonsteroidal anti-inflammatory drug use and illicit drug use are excluded. The most sensitive strategy for identifying patients in this group is to screen all patients who present with hypertension before age 25 years and after age 50 years. Other clues to secondary hypertension include abnormal renal function, evidence of early end-organ damage, unprovoked electrolyte abnormalities, abdominal bruits or asymmetrical pulses on physical examination, and poor response to therapy. Our patient used no drugs and presented with 4 features that suggested an underlying secondary cause: a young age, an abnormal creatinine level, severe hypertension, and the absence of family history for hypertension; therefore, a diagnosis of essential hypertension is unlikely.

Primary aldosteronism is found in 0.3% to 1.5% of patients with hypertension.[2,3] Primary aldosteronism is recognized more frequently by measuring serum aldosterone levels and plasma renin activity.[4] Although up to 20% of patients with primary aldosteronism may present with concentrations of serum potassium in the low end of normal, the combination of normal potassium and elevated plasma renin activity effectively rules out the diagnosis because almost all patients with primary aldosteronism have suppressed plasma renin activity.[5]

Pheochromocytoma and coarctation of the aorta represent less than 0.2% of all causes of hypertension and less than 10% of secondary causes. The absence of history that suggests pheochromocytoma and the lack of physical examination data that support coarctation of the aorta make both of these rare entities extremely unlikely.

Renal parenchymal disease and renovascular disease cause 5% to 10% of all hypertension, depending on the population studied. Renal parenchymal disease alone is responsible for 40% to 60% of hypertension among children and adolescents. Renovascular disease accounts for up to 25% of secondary forms of hypertension, although two thirds of cases are caused by atherosclerotic disease and affect a much older population. Therefore,

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See end of article for correct answers to questions.

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Table 1. **Laboratory Values**

Test	Values on admission
Hemoglobin (g/dL)	13.4
Leukocytes (× 10^9/L)	6.1
Platelet count (× 10^9/L)	273
Erythrocyte sedimentation rate (mm/1 h)	15
Sodium (mEq/L)	140
Potassium (mEq/L)	4.1
Calcium (mg/dL)	9.4
Phosphorus (mg/dL)	3.3
Chloride (mEq/L)	102
Bicarbonate (mEq/L)	24
Glucose (mg/dL)	88
Creatinine (mg/dL)	1.5*
Urea (mg/dL)	32
ALP (U/L)	25
AST (U/L)	16
ANA	<1.0 negative
Complement, total (U)	98
Plasma renin activity ($ng \cdot mL^{-1} \cdot h^{-1}$)	5.2*
Creatinine clearance ($mL \cdot min^{-1} \cdot 1.73\ m^{-2}$)	91
Urinary microscopy	Abnormal
RBC (/HPF)	1-3
WBC (/HPF)	1-3
Protein	Absent
RBC casts	Absent
Dysmorphic RBC	Absent

*Indicates abnormal value. ALP = alkaline phosphatase; ANA = antinuclear antibody; AST = aspartate aminotransferase; HPF = high-power field; RBC = red blood count; WBC = white blood count.

both epidemiologically and clinically, the most likely cause of hypertension in this patient is renal disease, and evaluation of the kidneys is the next obvious investigational step.

2. Which one of the following diagnostic tests would be the least helpful in this case?

a. Kidney biopsy
b. Magnetic resonance arteriography
c. Conventional arteriography
d. Duplex ultrasonography
e. Captopril renal scan

A renal etiology for this patient's hypertension would direct diagnostic investigation, and several clues from the history, physical examination, and preliminary laboratory studies need to be analyzed. The patient's good health, absence of analgesic or illicit drug use, normal physical examination findings, negative antinuclear antibodies, and, most importantly, normal urinalysis results suggest a diagnosis other than a parenchymal process such as glomerulonephritis, vasculitis, or analgesic nephropathy. Thus, kidney biopsy would be the least helpful test. Renovascular hypertension is a likely diagnosis because plasma renin activity and creatinine were elevated; therefore, a method to evaluate for renal artery stenosis (RAS) would provide valuable information. Also, in this age group, fibromuscular dysplasia is relatively common among those with renovascular hypertension, although it is more prevalent in women. Therefore, the diagnostic investigation should focus primarily on detecting possible RAS. Magnetic resonance or conventional arteriography, duplex ultrasonography, and captopril renal scan are all used in assessing for RAS, and the choice among them depends on the individual patient scenario.

3. Which one of the following would be the most appropriate next step in the investigation and management of this patient's condition?

a. Intravenous pyelography
b. Captopril renal scan
c. Duplex ultrasonography
d. Magnetic resonance arteriography
e. Conventional arteriography

Intravenous pyelography has no role in the diagnosis of RAS since it lacks sensitivity (70%) and specificity (85%). Captopril renal scan serves primarily as a screening tool and has excellent sensitivity and specificity (90%-95%); however, it provides a functional rather than anatomical diagnosis and is recommended when an intermediate clinical suspicion exists. Duplex ultrasonography is noninvasive, widely available, inexpensive, has 80% to 90% sensitivity and specificity, and has become the screening test of choice for RAS. However, it depends heavily on operator experience and is less useful for diagnosing fibromuscular dysplasia, the principal diagnostic consideration in this patient because of his age and renin-dependent hypertension. In this case, however, with the high pretest probability of RAS, a definitive test that provides anatomical diagnosis would be appropriate. The only 2 options that would definitively show RAS are magnetic resonance arteriography or conventional arteriography. Magnetic resonance arteriography of the renal arteries has a reported sensitivity of 94% to 97% and a specificity of 85% to 93%, the higher values being with gadolinium enhancement. The gold standard for diagnosing RAS is arteriography with intravenous contrast media, although this procedure is invasive and is associated with the greatest morbidity. Nevertheless, it is the only modality that offers the possibility of concomitant treatment with percutaneous angioplasty and stenting of the area of stenosis. This was the next step chosen in evaluating this patient.

An alternative diagnostic approach, given the history of trauma in this patient, would be to use ultrasonography or computed tomography (CT) to image the kidneys initially, before proceeding with arteriography. This approach, however, was not chosen because of the reasons mentioned earlier.

Conventional arteriography revealed normal renal arteries, but there was intrarenal vascular distortion caused apparently by a mass within the left kidney. Renin sampling of the renal veins was performed and results were abnormal: 10.1 ng · mL^{-1} · h^{-1} on the left and 3.8 ng · mL^{-1} · h^{-1} on the right, with a renal vein renin ratio (RVRR) of 2.7.

4. Which one of the following is the most likely etiology of the patient's renal mass, based on his presentation?

a. Wilms tumor
b. Renal cell carcinoma
c. Chronic renal abscess
d. Metastatic melanoma
e. Chronic intraparenchymal hematoma

Since the mass had not been visualized but only inferred from the vascular distortion it caused in the renal parenchyma, the obvious next step is to obtain imaging. The differential diagnosis of a renal mass depends heavily on its radiological appearance. Wilms tumor and renal cell carcinoma are both unlikely, given the patient's age, but both would be distinguished easily on CT. Additionally, because of the patient's overall excellent health, a renal abscess or metastatic melanoma would be highly unlikely. However, considering the patient's history of prior left flank trauma, a chronic intraparenchymal hematoma is the most likely diagnosis. Magnetic resonance imaging is the best technique for evaluating renal masses since it provides the most accurate information and in this case was the imaging procedure of choice.

Magnetic resonance imaging revealed a subcapsular, calcified hematoma (7.5 × 5.3 cm). Optimal management of the patient's hypertension is the next step.

5. Which one of the following is the most appropriate next step in managing this patient's hypertension?

a. Angiotensin-converting enzyme (ACE) inhibitor therapy
b. Observation with yearly follow-up
c. CT-guided aspiration of the hematoma
d. Surgical decapsulation and resection of the hematoma
e. Left nephrectomy

In patients with RAS, an RVRR of 1.5 or more is predictive of a beneficial blood pressure response to either revascularization or nephrectomy.[6] In this patient, the RVRR of 2.7 suggests that the hyperreninemic state and hypertension may be improved, and perhaps cured, by correcting the underlying cause. Given the patient's young age, it would be wise to pursue surgical intervention in an attempt to cure hypertension as an alternative to lifelong ACE therapy. Simple observation would be inadequate in the setting of established hypertension likely secondary to kidney trauma and organized hematoma. It is unlikely, given the age and extensive calcification of the hematoma, that needle aspiration could be used successfully to remove the hematoma. It was unclear whether renal decapsulation with resection of the hematoma or total nephrectomy should be conducted. However, because the condition was benign, a surgical strategy designed to spare the left kidney seemed preferable, and our patient underwent decapsulation with resection of the hematoma. Within a week after surgery, his blood pressure level returned to normal, and at 1-year follow-up he remained normotensive without the use of antihypertensive medication.

DISCUSSION

Our case is a classic example of direct renal compression by a subcapsular calcified hematoma resulting in systemic hypertension. Intrarenal subcapsular hematoma as a cause of curable hypertension was first described in 1939 by Page[7] and has since been known as Page kidney. Page described a new paradigm for systemic hypertension. After he wrapped cellophane around the kidneys of dogs, cats, and rabbits, hypertension developed within 3 to 5 weeks when a fibrous capsule developed around the wrapped kidneys.

Sixteen years later, Engel and Page[8] reported the first clinical correlate to Page's pathophysiological model: hypertension developed in a football player after flank trauma occurred and a renal subcapsular hematoma developed. The pathophysiology of hypertension in this model is believed to involve renal ischemia with concurrent hyperreninemia.[9,10] Approximately 80 cases of Page kidney have been described, and preliminary review of the Mayo Clinic experience has yielded 27 cases over the past 35 years.

The main causes of Page kidney are trauma from football and other contact sports, trauma unrelated to sports, motor vehicle accidents, and miscellaneous causes such as tumor, biopsy, renal transplantation, and renal artery dissection.[11] Accepted criteria for diagnosing Page kidney include the presence of hypertension, documentation of renal subcapsular hematoma, and improvement of hypertension with surgical intervention. Although ultrasonography and CT are used more often as diagnostic methods, magnetic resonance imaging was identified recently as a useful tool with excellent resolution. Hypertension should be medically managed, preferably with ACE inhibition, although no clinical trial supports this assumption.

Definitive management of Page kidney is with surgery.[12] Surgical options include percutaneous or surgical drainage of the hematoma, decapsulation, or subtotal or total nephrectomy. Renal vein renin sampling may help predict the success of surgical intervention if the affected side shows hyperreninemia,[6] as in our case.

This case illustrates several points about a rare and curable cause of hypertension: (1) the need to identify patients who need work-up for secondary causes of hypertension, (2) diagnostic strategies of secondary hypertension, and (3) investigation of the differential diagnosis of renal masses.

CONCLUSIONS

Although rare, Page kidney is one of the few curable causes of hypertension, and diagnosis requires a high degree of awareness of young, active patients presenting with hypertension and a history of trauma. Curing hypertension can be achieved by using a conservative surgical approach that spares the affected kidney. Recognizing and treating Page kidney may avert considerable morbidity and mortality associated with long-standing hypertension.

REFERENCES

1. Rudnick KV, Sackett DL, Hirst S, Holmes C. Hypertension in a family practice. *Can Med Assoc J*. 1977;117:492-497.
2. Sinclair AM, Isles CG, Brown I, Cameron H, Murray GD, Robertson JW. Secondary hypertension in a blood pressure clinic. *Arch Intern Med*. 1987;147:1289-1293.
3. Anderson GH Jr, Blakeman N, Streeten DH. The effect of age on prevalence of secondary forms of hypertension in 4429 consecutively referred patients. *J Hypertens*. 1994;12:609-615.
4. Lim PO, Rodgers P, Cardale K, Watson AD, MacDonald TM. Potentially high prevalence of primary aldosteronism in a primary-care population [letter]. *Lancet*. 1999;353:40.
5. Ganguly A. Primary aldosteronism. *N Engl J Med*. 1998;339:1828-1834.
6. Safian RD, Textor SC. Renal-artery stenosis. *N Engl J Med*. 2001;344:431-442.
7. Page IH. The production of persistent arterial hypertension by cellophane perinephritis. *JAMA*. 1939;113:2046-2048.
8. Engel WJ, Page IH. Hypertension due to renal compression resulting from subcapsular hematoma. *J Urol*. 1955;73:735-739.
9. Mullins MF, Nilson JP, Ross G Jr. Unilateral "Page kidney" hypertension in man: studies of the renin-angiotensin-aldosterone system before and after nephrectomy. *JAMA*. 1975;231:42-45.
10. Nakano S, Kigoshi T, Uchida K, Morimoto S, Tsugawa R, Matsunou H. Hypertension and unilateral renal ischemia (Page kidney) due to compression of a retroperitoneal paraganglioma. *Am J Nephrol*. 1996;16:91-94.
11. McCune TR, Stone WJ, Breyer JA. Page kidney: case report and review of the literature. *Am J Kidney Dis*. 1991;18:593-599.
12. Moriarty KP, Lipkowitz GS, Germain MJ. Capsulectomy: a cure for the Page kidney. *J Pediatr Surg*. 1997;32:831-833.

Correct answers: 1. *e*, 2. *a*, 3. *e*, 4. *e*, 5. *d*