

SIGNS AND SYMPTOMS OF CARDIOVASCULAR SYSTEM DISEASES (syndrome of arterial hypertension)

LECTURE IN INTERNAL MEDICINE PROPAEDEUTICS

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Plan of the lecture



The blood flowing inside vessels exerts a force against the walls – this is blood pressure

Arterial hypertension

- Definition
- Classification
- Causes
- Clinical picture
- Diagnosis

(Arterial) hypertension: definition

- Hypertension (HTN or HT), also known as high blood pressure or arterial hypertension, is a chronic medical condition in which the blood pressure in the arteries is elevated
- Hypertension is having a blood pressure higher than 139 over 89 (≥ 140 and/or ≥ 90) mmHg for most adults; different criteria apply to children

(Arterial) hypertension: types

- Primary (essential) hypertension (90% cases), defined as high blood pressure with no obvious underlying cause
- Secondary hypertension (10% cases), , defined as high blood pressure due to an identifiable cause, such as chronic kidney disease, narrowing of the aorta or kidney arteries; endocrine disorders such as excess aldosterone, cortisol, catecholamines overproduction, etc.

US MLE TEST

A 75-year-old man with hypercholesterolemia, coronary artery disease, and history of a transient ischemic attack (TIA) comes to your office for evaluation of hypertension.

Previously, his blood pressure was controlled with diet and an ACE inhibitor. Today, his blood pressure is 180/115 mm Hg, and his creatinine is increased from 0.54 to 1.2 mg/dL. The patient reports that he has been compliant with his diet and blood pressure medications. What is the most likely cause of his hypertension?

1. Progression of his essential hypertension,
2. Renal artery stenosis,
3. Coarctation of the aorta,
4. Pheochromocytoma,
5. Hypothyroidism

US MLE TEST EXPLANATION

The correct answer is 2. The patient most likely has renal artery stenosis, which is suggested by the history of coronary artery disease, dyslipidemia, and TIA, and the increased creatinine in response to an ACE inhibitor.

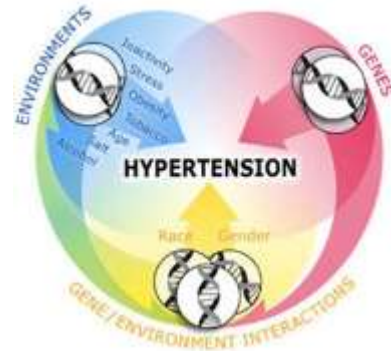
Incorrect Answers:

1: Creatinine should not increase in response to an ACE inhibitor in essential hypertension, 3: Coarctation of the aorta is associated with an arm to leg systolic blood pressure difference of >20 mmHg, 4: Pheochromocytoma is associated with periodic flushing and sweating, 5: Hyperthyroidism, not hypothyroidism, is associated with hypertension.

(Arterial) hypertension:
classification of blood pressure (mm Hg) for adults

Category	Systolic	Diastolic
Normal	90–119	60–79
High normal (Prehypertension)	120–139	80–89
Stage 1 hypertension	140–159	90–99
Stage 2 hypertension	160–179	100–109
Stage 3 hypertension (Hypertensive emergency)	≥180	≥110
Isolated systolic hypertension	≥140	<90

(Arterial) hypertension: causes of primary hypertension



- Hypertension results from a complex interaction of genes and environmental factors
- Numerous common genetic variants with small effects on blood pressure have been identified as well as some rare genetic variants with large effects on blood pressure, but the genetic basis of hypertension is still poorly understood

(Arterial) hypertension: causes of secondary hypertension

- Kidney disease
 - Cushing's syndrome
 - Hyperthyroidism
 - Hypothyroidism
 - Acromegaly
 - Conn's syndrome
 - Hyperaldosteronism
 - Hyperparathyroidism
 - Pheochromocytoma
 - Obesity
 - Sleep apnea
 - Pregnancy
 - Drug-induced
 - Etc.
- (other causes)

(Arterial) hypertension: hypertensinogenic (risk) factors

- Age
- Race
- Sex
- Family history
- Obesity
- A sedentary lifestyle
- Insulin resistance
- Using tobacco
- High alcohol intake
- High salt intake
- Stress
- Dyslipidemia
- Low potassium intake
- Low calcium intake
- Too little vitamin D in diet
- Certain chronic conditions

(Arterial) hypertension:

SCORE and HeartScore (<http://www.heartscore.org>)

- SCORE (Systematic Coronary Risk Evaluation) is a cardiovascular disease risk assessment system initiated by the European Society of Cardiology
- SCORE is based on the risk factors: gender, age, smoking, systolic blood pressure and total cholesterol
- HeartScore is the interactive version of SCORE
- The threshold for high risk based on fatal cardiovascular events is defined as "higher than 5%", instead of the previous "higher than 20%" using a composite coronary endpoint

(Arterial) hypertension: stratification of total cardiovascular disease risk

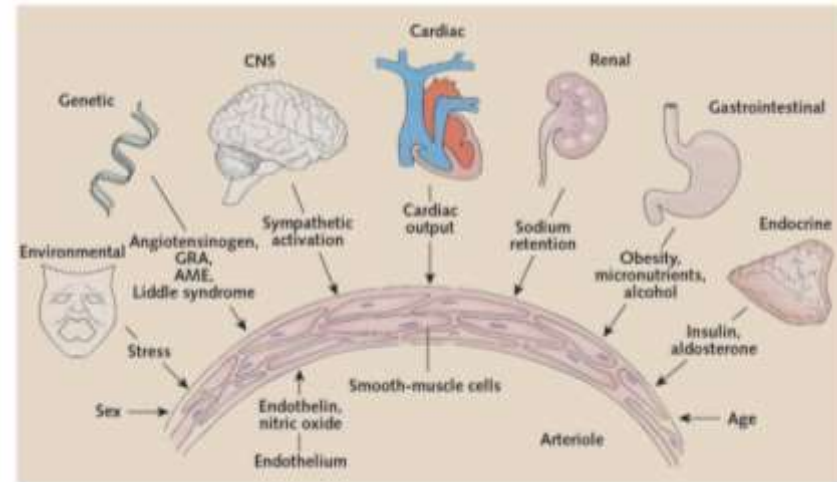
Other risk factors, asymptomatic organ damage or disease	Blood Pressure (mmHg)			
	High normal SBP 130–139 or DBP 85–89	Grade 1 HT SBP 140–159 or DBP 90–99	Grade 2 HT SBP 160–179 or DBP 100–109	Grade 3 HT SBP ≥180 or DBP ≥110
No other RF		Low risk	Moderate risk	High risk
1–2 RF	Low risk	Moderate risk	Moderate to high risk	High risk
≥3 RF	Low to Moderate risk	Moderate to high risk	High Risk	High risk
OD, CKD stage 3 or diabetes	Moderate to high risk	High risk	High risk	High to very high risk
Symptomatic CVD, CKD stage ≥4 or diabetes with OD/RFs	Very high risk	Very high risk	Very high risk	Very high risk

BP = blood pressure; CKD = chronic kidney disease; CV = cardiovascular; CVD = cardiovascular disease; DBP = diastolic blood pressure; HT = hypertension; OD = organ damage; RF = risk factor; SBP = systolic blood pressure.

(Arterial) hypertension: pathophysiology

Key factors:

- Abnormal Na transport
- Increased sympathetic nervous activity
- Increased renin-angiotensin-aldosterone system activity
- Vasodilator deficiency



AME - apparent mineralocorticoid excess; CNS - central nervous system; GRA - glucocorticoid-remediable aldosteronism

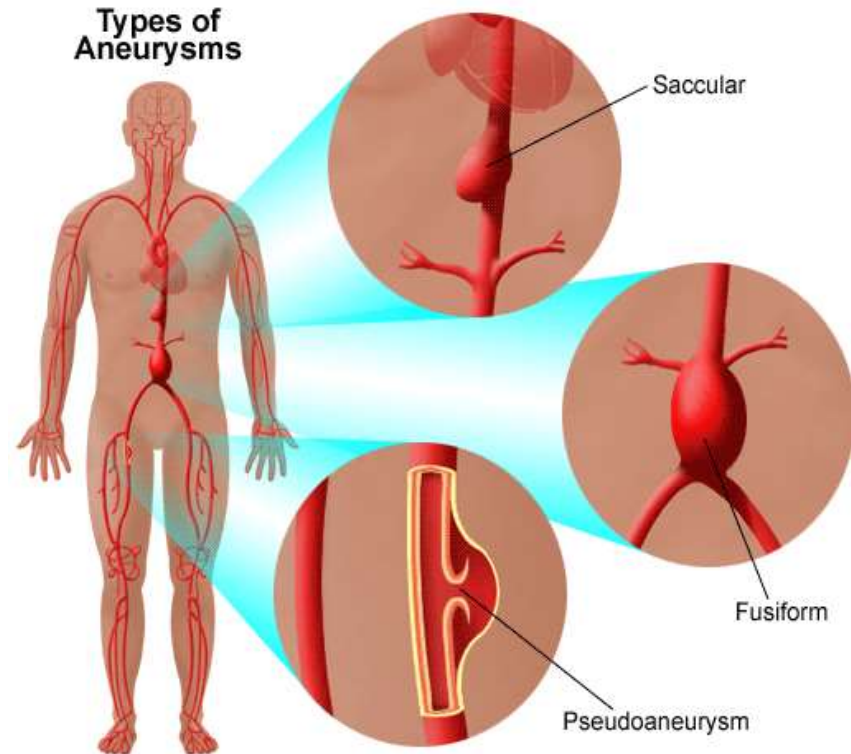
(Arterial) hypertension: signs and symptoms



- Most people with high blood pressure have no signs or symptoms, even if blood pressure readings reach dangerously high levels
- A few people with high blood pressure may have headaches, shortness of breath or nosebleeds, but these signs and symptoms aren't specific and usually don't occur until high blood pressure has reached a severe or life-threatening stage

(Arterial) hypertension: main complications

- Hypertensive heart disease
- Coronary artery disease
- Stroke
- Aortic aneurysm
- Peripheral artery disease
- Chronic kidney disease
- Chronic heart failure
- Hypertensive retinopathy

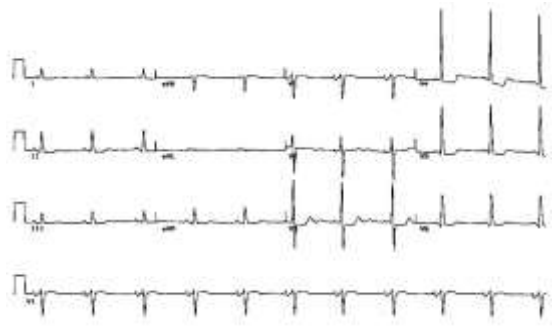


(Arterial) hypertension: medical history 1

- The known duration of hypertension and previously recorded levels
- Any history or symptoms of coronary artery disease (CAD), heart failure (HF)
- Other relevant coexisting disorders (e.g., stroke, renal dysfunction, peripheral arterial disease, dyslipidemia, diabetes, gout)
- Family history of any of these disorders

(Arterial) hypertension: medical history 2

- Social history includes exercise levels and use of tobacco, alcohol, and stimulant drugs (prescribed and illicit)
- A dietary history focuses on intake of salt and stimulants (e.g., tea, coffee, caffeine-containing sodas, energy drinks)
- Lifestyle factors
- Current and previous medications



US MLE TEST



A 75-year-old over-weight gentleman with a long history of uncontrolled hypertension, diabetes, smoking and obesity is presenting to his primary care physician with a chief complaint of increased difficulty climbing stairs and the need to sleep propped up by an increasing number of pillows at night. On physical examination the patient has an extra heart sound just before S1 heard best over the cardiac apex and clear lung fields. The EKG and chest x-ray are attached (Figures A and B respectively). What is the largest contributor to this patient's symptoms?

1. Long-term smoking,
2. Uncontrolled Hypertension,
3. Obesity,
4. Sleep Apnea,
5. Acute Myocardial Infarction.

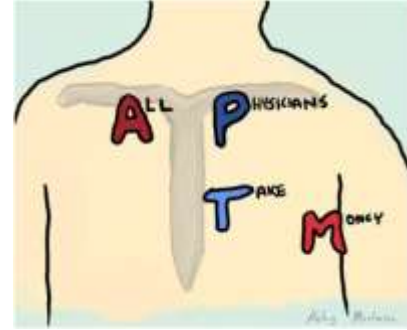
US MLE TEST EXPLANATION

The correct answer is 2. This patient is presenting with diastolic heart failure secondary to long-term uncontrolled hypertension. The extra heart sound or S4 occurs due to decreased compliance of the left ventricle.

Incorrect Answers:

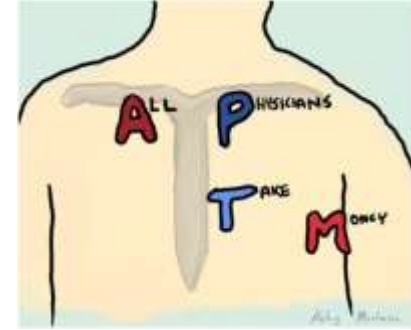
1, 3, 4: While obesity, sleep apnea and smoking all contribute to hypertension, it is the control of the hypertension that is the most significant contributor to this patient's diastolic heart failure, 5: This scenario does not appear to be an acute event. History of myocardial infarction often results in systolic heart failure.

(Arterial) hypertension: physical examination 1



- Height, weight, and waist circumference
- Funduscopic examination for retinopathy
- Auscultation for bruits in the neck and abdomen (a unilateral renal artery bruit may be heard in slim patients with renovascular hypertension)
- Full cardiac, respiratory, and neurologic examination

(Arterial) hypertension: physical examination 1



- Heart auscultation (a 4th heart sound is one of the earliest signs of hypertensive heart disease)
- The abdomen palpation for kidney enlargement and abdominal masses
- Peripheral arterial pulses investigation (diminished or delayed femoral pulses suggest aortic coarctation, particularly in patients < 30)

(Arterial) hypertension: hypertensive crisis



- Severely elevated blood pressure equal to or greater than a systolic 180 or diastolic of 110 is referred to as a hypertensive crisis
- Hypertensive crisis is categorized as hypertensive urgency, according to the presence or absence of end organ damage
- The most affected organs include the brain, kidney, heart, aorta and lungs

(Arterial) hypertension: diagnosis 1



- Multiple measurements of blood pressure (BP) to confirm
- Urinalysis and urinary albumin: creatinine ratio
- Blood tests: fasting lipids, hematocrit, creatinine, serum potassium (K), creatinine (or the corresponding estimated glomerular filtration rate), calcium, lipid profile, glucose
- Renal ultrasonography if creatinine increased

(Arterial) hypertension: diagnosis 2



- Evaluate for aldosteronism if K decreased
- ECG: If left ventricular hypertrophy, consider echocardiography
- Sometimes measurement of thyroid-stimulating hormone, T3-T4 hormones, cortisol
- Evaluation for pheochromocytoma or a sleep disorder if BP elevation sudden and labile or severe

(Arterial) hypertension: office blood pressure monitoring 1

- The patient should be seated comfortably with the back supported and the upper arm bared without constrictive clothing
- The legs should not be crossed
- The arm should be supported at the level of the heart, and the bladder of the blood pressure (BP) cuff should encircle at least 80% of the arm circumference

(Arterial) hypertension: office blood pressure monitoring 2

- The BP measuring device should be deflated at the rate of 2 to 3 mm/sec, and the first and last audible sounds should be taken as the systolic and diastolic pressure respectively
- Neither the patient nor the observer should talk during the measurement

(Arterial) hypertension: office blood pressure monitoring 3

- Measurements may be both while seated and after standing, to look for orthostatic or postural hypotension
- At least the first measurement should be done on the right and left arms

(Arterial) hypertension: office blood pressure monitoring



Man getting his blood pressure taken at the doctor's office

(Arterial) hypertension: ambulatory blood pressure monitoring 1

- The National Institute of Health and Clinical Excellence (NICE) guidelines recommend that a diagnosis of primary hypertension should be confirmed with 24-hour ambulatory blood pressure monitoring or home blood pressure monitoring rather than by relying solely on office blood pressure measurement

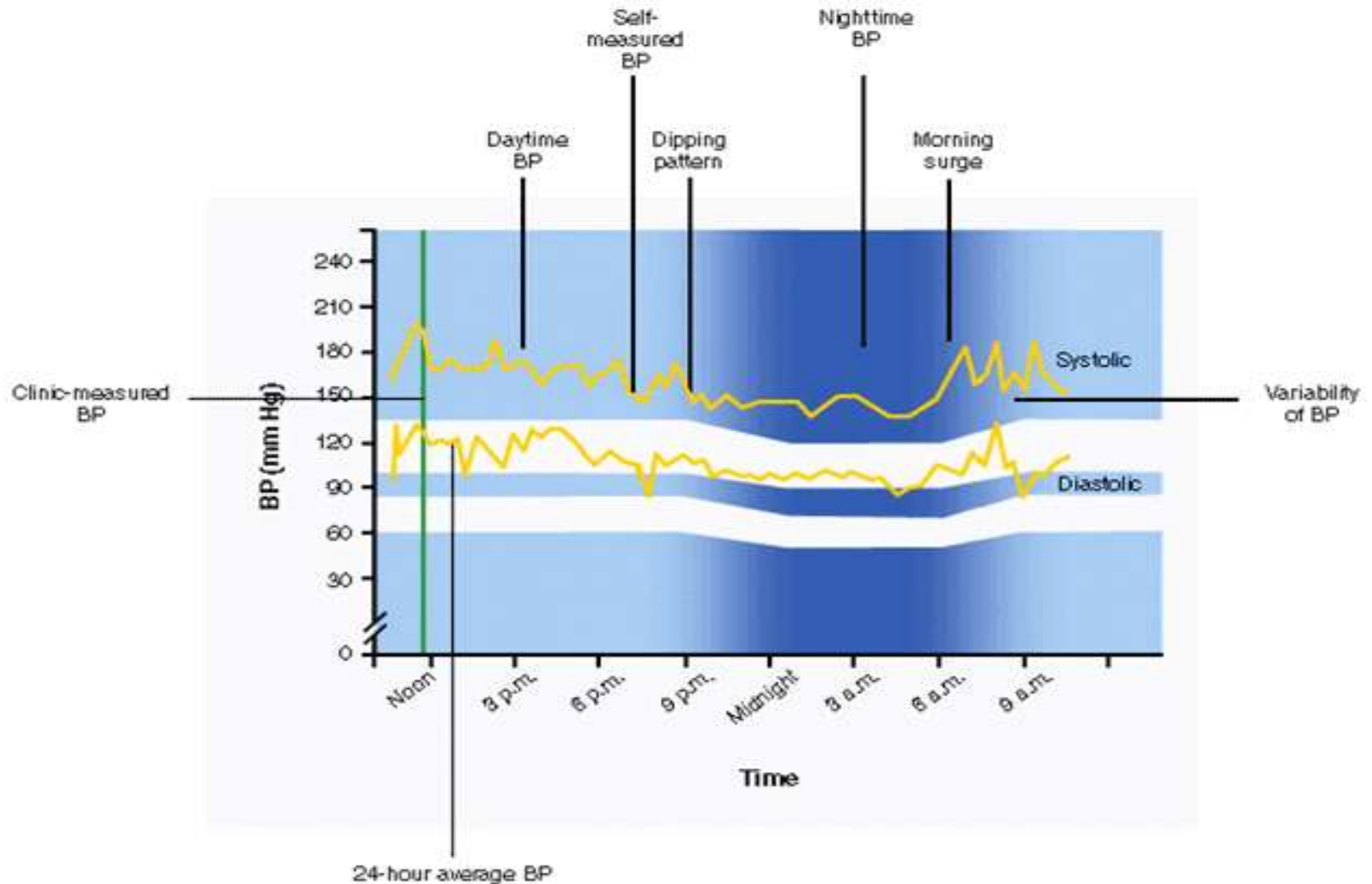
(Arterial) hypertension: ambulatory blood pressure monitoring 2

- Twenty-four-hour ambulatory BP monitoring is indicated to rule out white-coat hypertension, to uncover apparent drug resistance (office resistance), to better define resistant hypertension, to identify hypotensive symptoms while the patient is being treated with anti-hypertensive medications, to monitor episodic hypertension, and to identify autonomic dysfunction states

(Arterial) hypertension: ambulatory blood pressure monitoring 3

- Twenty-four-hour ambulatory BP monitoring also helps identify abnormal patterns in blood pressure that could remain undetected if a patient is evaluated based on physician office blood pressure measurements alone

(Arterial) hypertension: ambulatory blood pressure monitoring



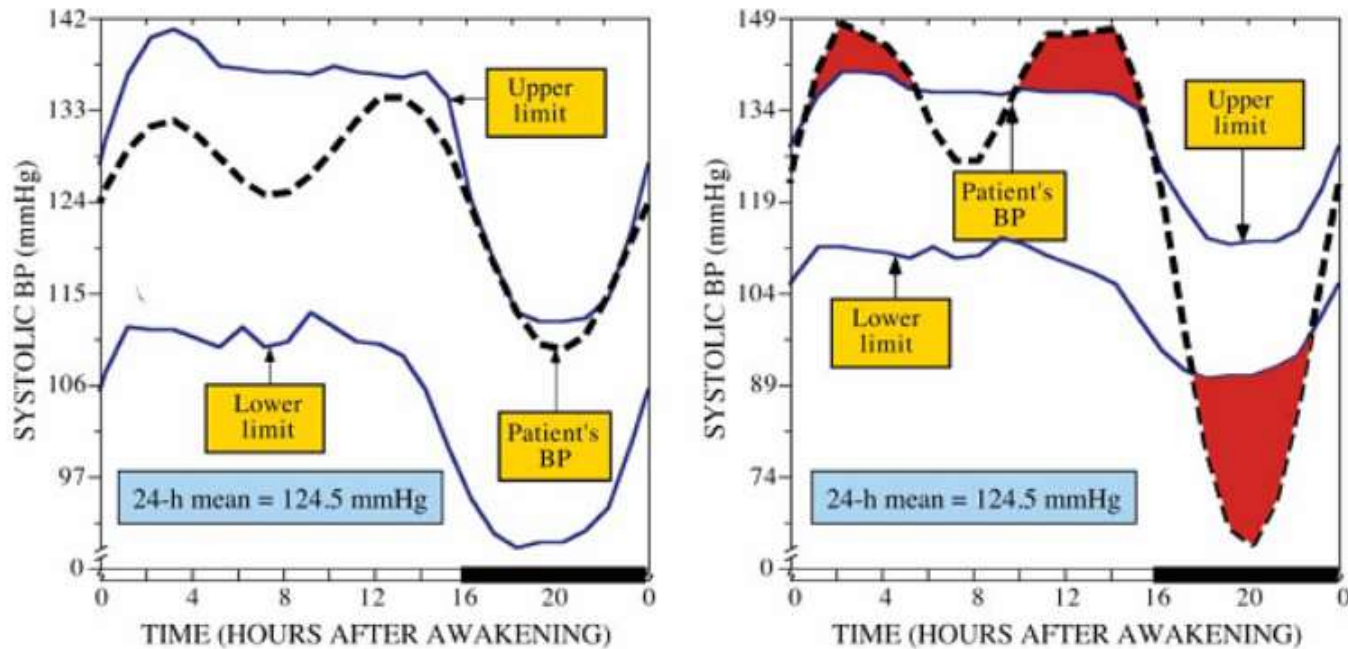
(Arterial) hypertension: extent of the night time BP attenuation 1

- The extent of the nighttime BP attenuation has been mainly quantified through the so-called “sleep-time relative BP decline”, which is defined as the percent decrease in mean BP during nighttime sleep relative to the mean BP during daytime activity

(Arterial) hypertension:
extent of the night time BP attenuation 2

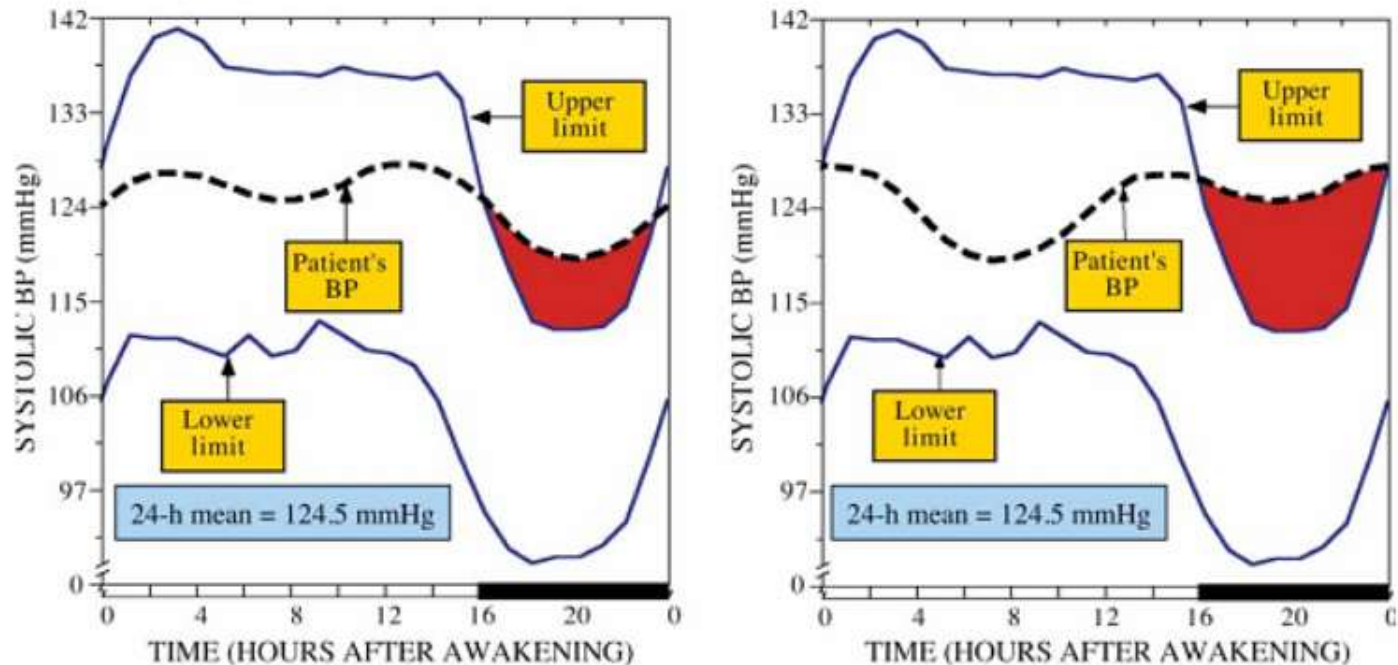
- More recently, the classification has been extended by dividing individuals into four groups:
- Extreme-dippers (sleep-time relative BP decline $>20\%$)
- Dippers (sleep-time relative BP decline $\geq 10\%$ but $<20\%$)
- Non dippers (sleep-time relative BP decline $<10\%$)
- Inverse-dippers or risers (sleep-time relative BP decline $<0\%$, indicating asleep BP $>$ awake BP mean)

(Arterial) hypertension: ambulatory blood pressure monitoring



24-h SBP pattern (dashed thick lines) of a normotensive dipper subject (left) and a hypertensive extreme-dipper patient (right), plotted with respect to circadian time-specified tolerance limits(continuous thin lines)

(Arterial) hypertension: ambulatory blood pressure monitoring



24-h SBP pattern (dashed thick lines) of a hypertensive non-dipper (left) and a hypertensive riser patient (right), plotted with respect to circadian time-specified tolerance limits (continuous thin lines), calculated from a reference population of normotensive individuals as a function of their rest-activity cycle and sex.

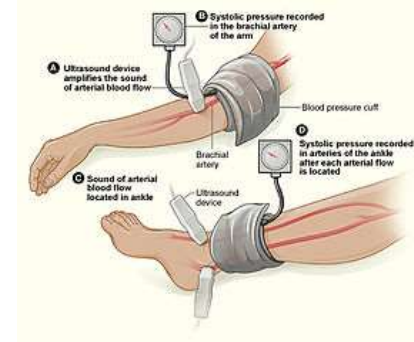
(Arterial) hypertension: home blood pressure monitoring 1

- The home BP is a better predictor of cardiovascular morbidity and mortality than are office BP measurements
- Hypertension is defined as a mean home blood pressure of $\geq 135/85$ mmHg
- Home blood pressure monitoring provides an inexpensive alternative to 24-hour ambulatory BP monitoring which is not yet widely available

(Arterial) hypertension: home blood pressure monitoring 2

- One of the main drawbacks in home blood pressure measurement when compared to 24-hour ambulatory BP monitoring, is that sleep time blood pressures cannot be recorded and therefore those patients with abnormal dipping pattern in blood pressure and nocturnal hypertension will be missed

(Arterial) hypertension: ankle brachial index



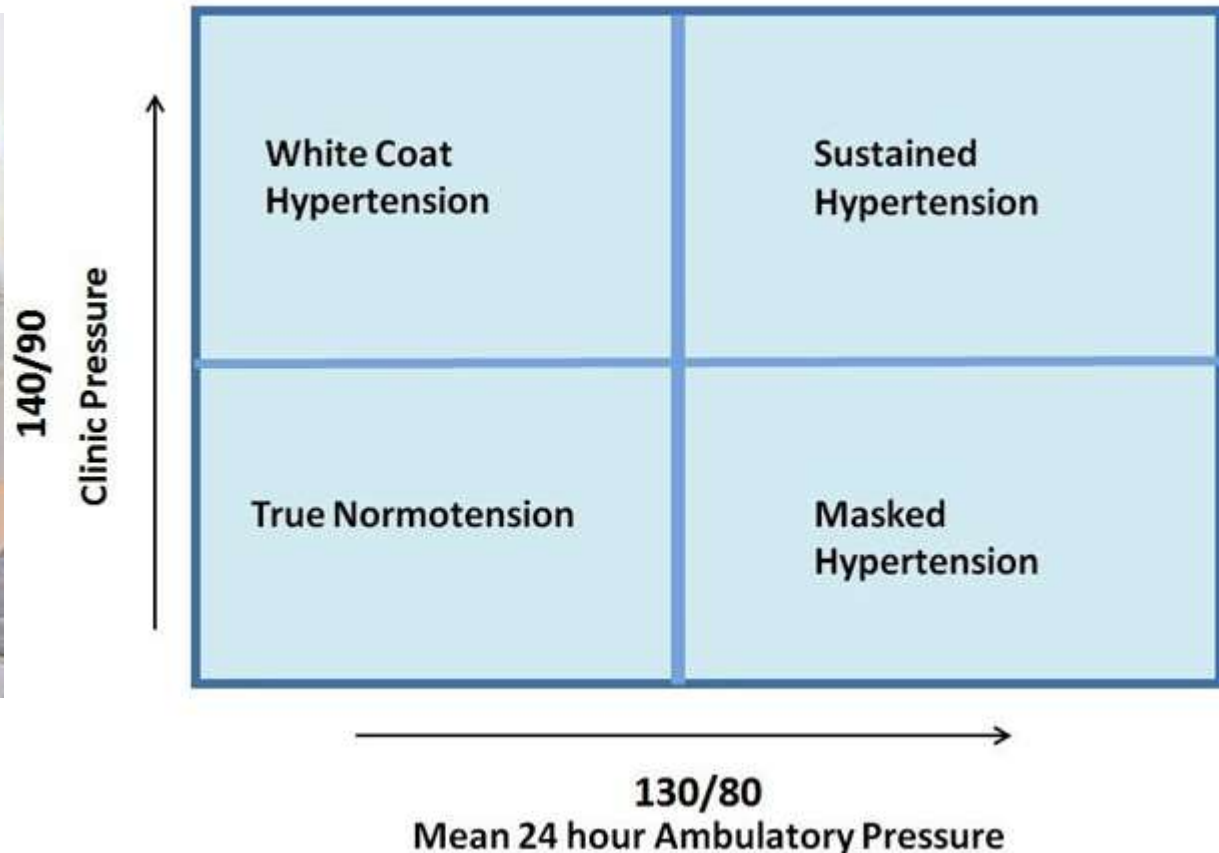
- The ankle brachial pressure index (ABPI or ankle brachial index (ABI) is the ratio of the blood pressure in the lower legs to the blood pressure in the arms
- Compared to the arm, lower blood pressure in the leg is an indication of blocked arteries (peripheral artery disease or PAD) or secondary arterial hypertension due to aortic coarctation

(Arterial) hypertension: ankle brachial index interpretation

ABPI value	Interpretation	Action	Nature of ulcers, if present
above 1.2	Abnormal vessel hardening from PVD	Refer routinely	Venous ulcer use full compression bandaging
1.0 - 1.2	Normal range	None	
0.9 - 1.0	Acceptable		
0.8 - 0.9	Some arterial disease	Manage risk factors	
0.5 - 0.8	Moderate arterial disease	Routine specialist referral	Mixed ulcers use reduced compression bandaging
under 0.5	Severe arterial disease	Urgent specialist referral	Arterial ulcers no compression bandaging used

ABPI - the ankle brachial pressure index

(Arterial) hypertension: patterns of blood pressure



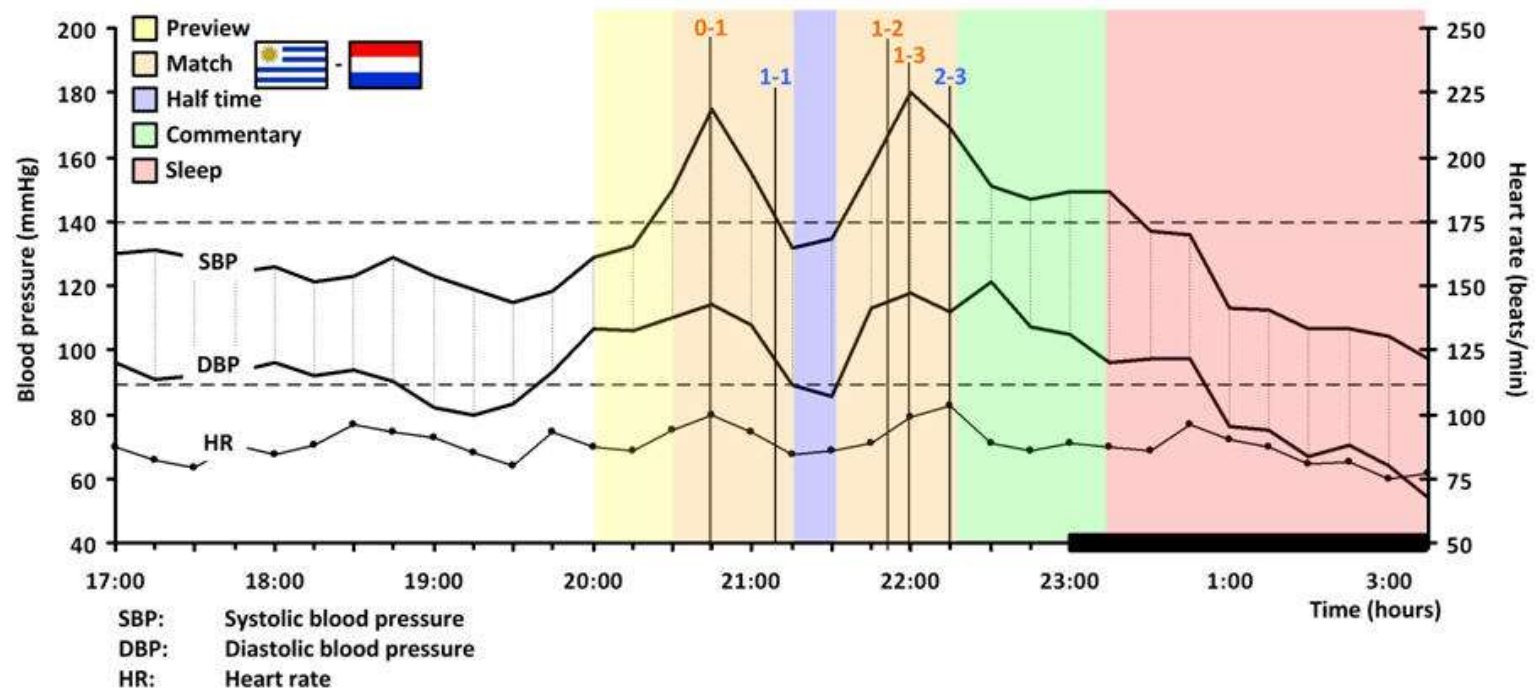
The time of change
color and model of coat

(Arterial) hypertension: white coat hypertension



- White coat hypertension, more commonly known as white coat syndrome, is a phenomenon in which patients exhibit a blood pressure level above the normal range, in a clinical setting, though they don't exhibit it in other settings
- It is believed that the phenomenon is due to anxiety that those afflicted experience, during a clinic visit

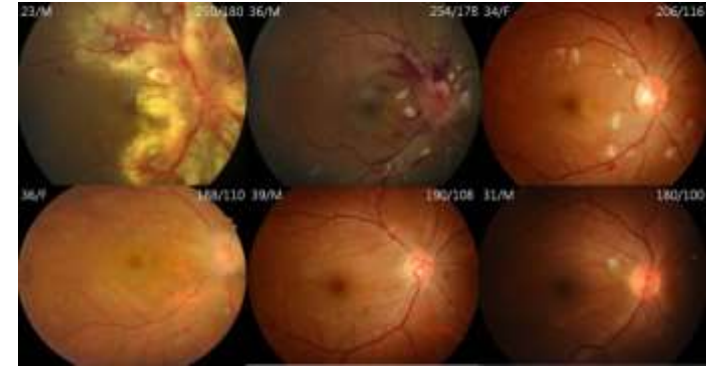
(Arterial) hypertension: masked hypertension



The term "masked hypertension" describes the contrasting to the white coat hypertension phenomenon

(Arterial) hypertension: Keith Wagener Barker (KWB) grades of hypertensive retinopathy 1

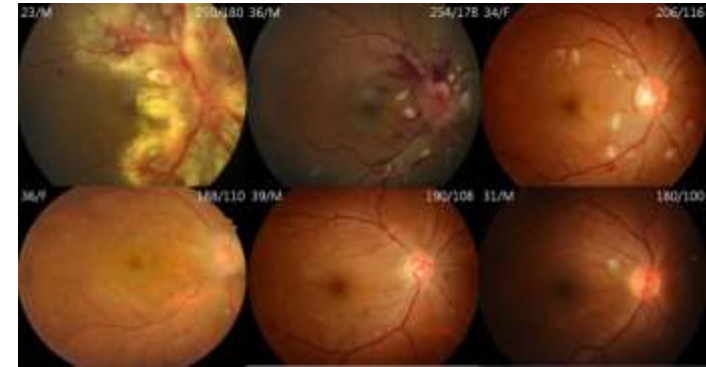
- Hypertensive retinopathy is damage to the retina and retinal circulation due to high blood pressure
- KWB grades:
 - 1 - Arteriolar constriction/attenuation/sclerosis - `silver wiring` and vascular tortuosities



Peripapillary and periarteriolar retinal changes are apparent, including cotton wool spots, retinal hemorrhages, and exudates

(Arterial) hypertension: Keith Wagener Barker (KWB) grades of hypertensive retinopathy 2

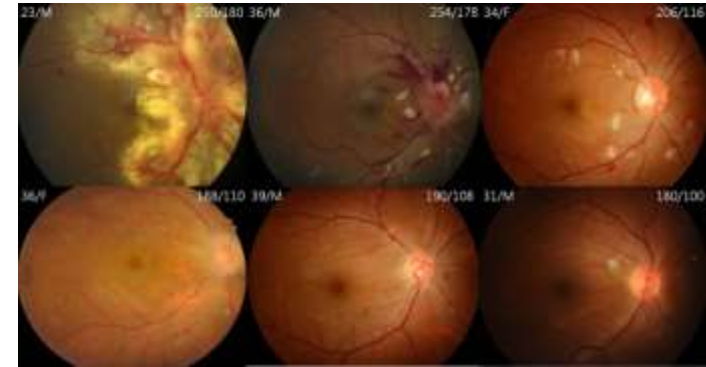
- Hypertensive retinopathy is damage to the retina and retinal circulation due to high blood pressure
- KWB grades:
 - 2 - As grade 1 + Irregularly located, tight constrictions - known as `AV nicking` or `AV nipping`



Peripapillary and periarteriolar retinal changes are apparent, including cotton wool spots, retinal hemorrhages, and exudates

(Arterial) hypertension: Keith Wagener Barker (KWB) grades of hypertensive retinopathy 3

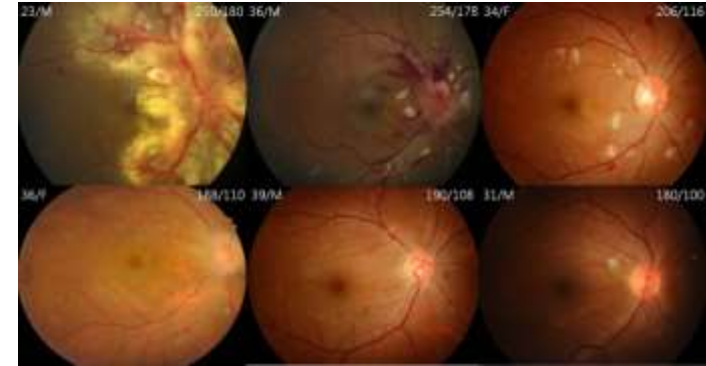
- Hypertensive retinopathy is damage to the retina and retinal circulation due to high blood pressure
- KWB grades:
 - 4 - As grade 2 + Retinal edema, cotton wool spots and flame-hemorrhages



Peripapillary and periarteriolar retinal changes are apparent, including cotton wool spots, retinal hemorrhages, and exudates

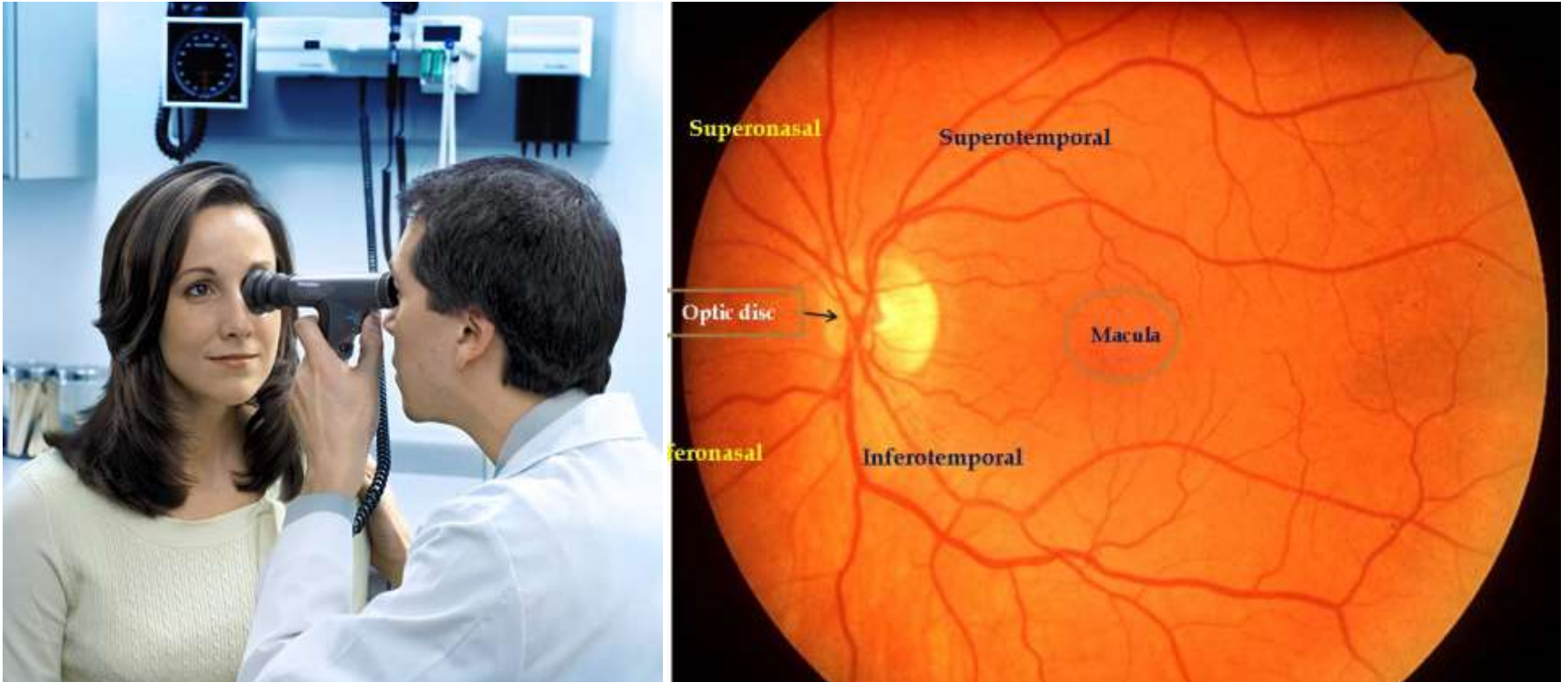
(Arterial) hypertension: Keith Wagener Barker (KWB) grades of hypertensive retinopathy 4

- Hypertensive retinopathy is damage to the retina and retinal circulation due to high blood pressure
- KWB grades:
 - 4 - As grade 3 + swelling of the optic disc (papilloedema) + macular star



Peripapillary and periarteriolar retinal changes are apparent, including cotton wool spots, retinal hemorrhages, and exudates

(Arterial) hypertension: ophthalmoscopy



Normal Fundus

US MLE TEST

A 14-year-old male presents to his physician with complaints of shortness of breath and easy fatigability when exercising for extended periods of time. When he exercises, his lower legs and feet turn a bluish-gray color. He cannot remember visiting a doctor since he was in elementary school. His vital signs are as follows: HR 72, BP 148/65, RR 14, and SpO2 97%. Which of the murmurs and/or findings would be expected on auscultation?

1. Mid-systolic murmur loudest at the right second intercostal space,
2. Holodiastolic murmur loudest at the apex, with an opening snap following the S2 heart sound,
3. Left infraclavicular systolic ejection murmur,
4. Continuous, machine-like murmur at the left infraclavicular area,
5. Right supraclavicular continuous murmur which disappears with pressure on the internal jugular vein.

US MLE TEST EXPLANATION

The correct answer is 4. This patient's presentation of exercise intolerance, lower extremity cyanosis, and a widened pulse pressure is consistent with a diagnosis of patent ductus arteriosus (PDA). A continuous, machine-like murmur loudest at the left infraclavicular area is associated with PDA.

Incorrect Answers:

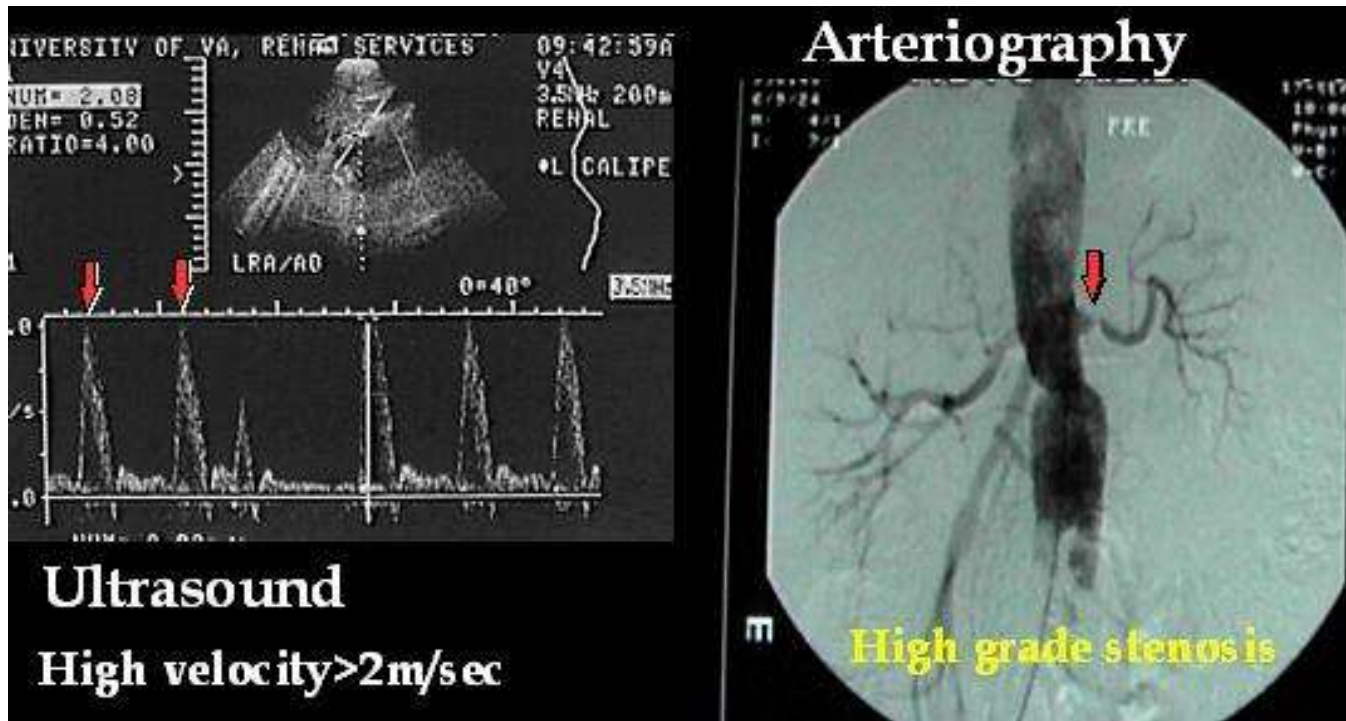
1: A mid-systolic murmur loudest at the right second intercostal space, with radiation to the right neck is suggestive of aortic stenosis, 2: Mitral stenosis is associated with a holodiastolic murmur loudest at the apex accompanied by an opening snap following the S2 heart sound, 3: A systolic murmur with weak femoral pulses and decreased lower extremity blood pressures is suggestive of coarctation of the aorta, 5: A continuous murmur at the right supraclavicular area that is obliterated by pressure on the ipsilateral internal jugular vein is suggestive of a venous hum - a common innocent murmur.

(Arterial) hypertension: renal sonography



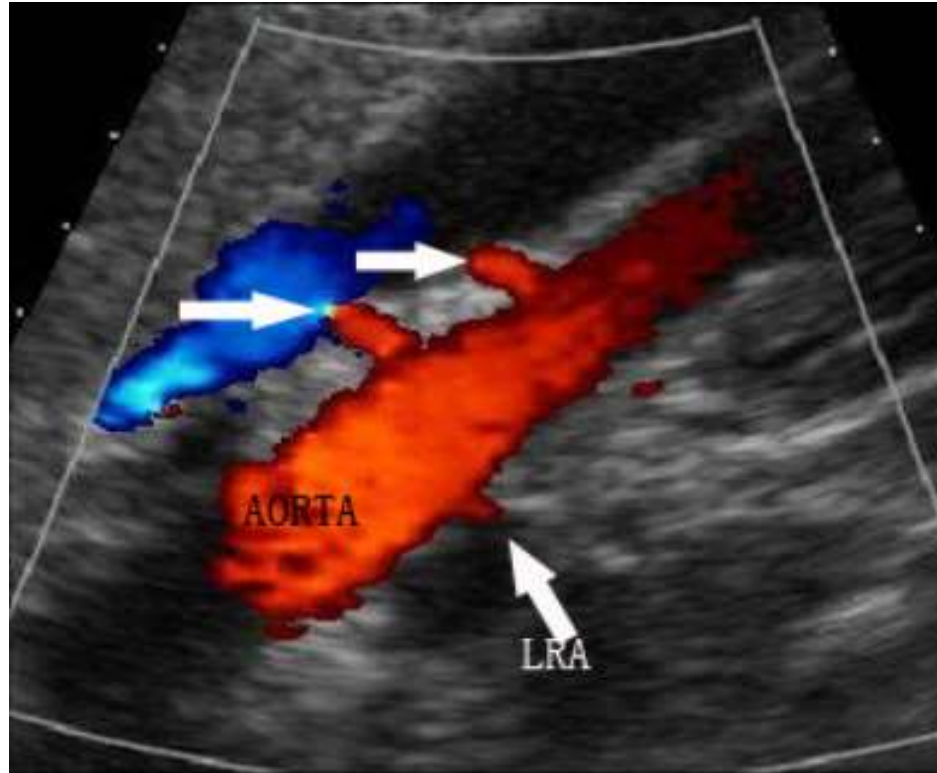
The size of the left kidney is small (8.37 cm in length) and echogenicity of the kidney is increased in a patient with left renal artery stenosis

(Arterial) hypertension: combine renal artery Doppler ultrasound and arteriography



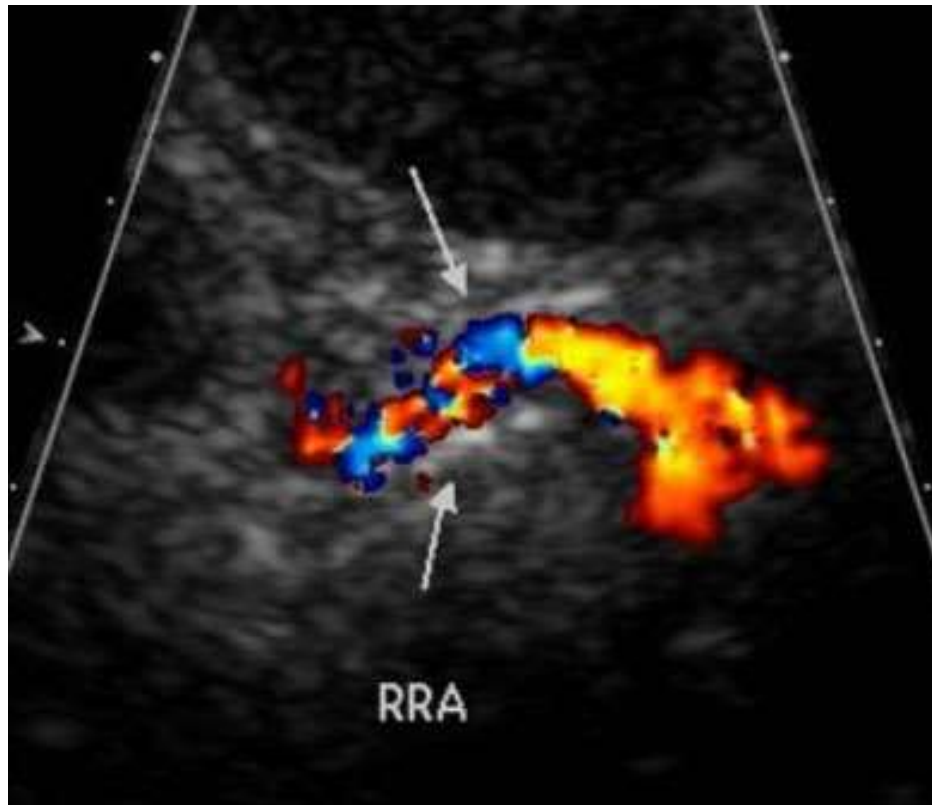
Renal artery Doppler ultrasound (1) screening for renal artery stenosis shows very high velocity flow at the level of the left renal artery origin from the aorta; subsequent arteriogram (2) shows tight stenosis at the left renal artery ostium

(Arterial) hypertension: renal color duplex sonography



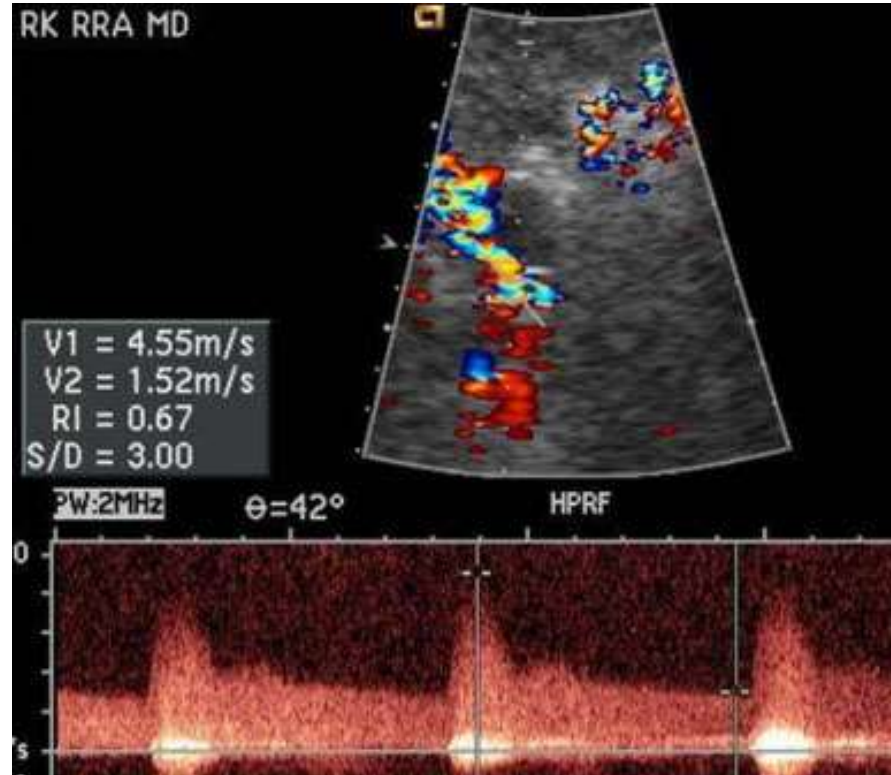
Normal appearance of the right renal artery, right accessory renal artery, single left renal artery (arrows), and abdominal aorta on longitudinal view of color flow image. LRA, left renal artery

(Arterial) hypertension: renal color duplex sonography



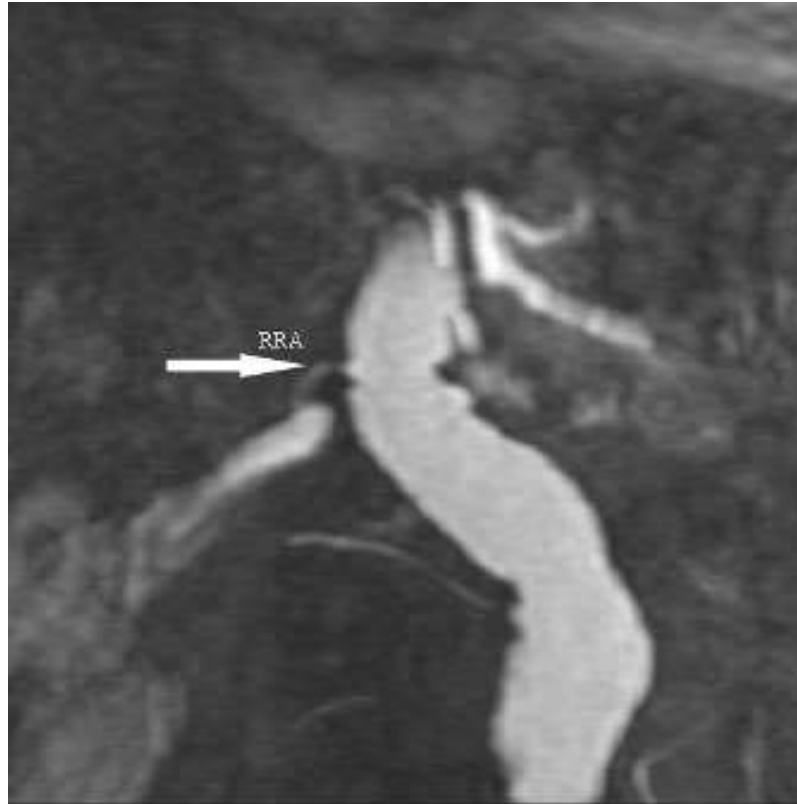
Remarkably turbulent flow at the stenosis of the right proximal renal artery on longitudinal view of color flow image

(Arterial) hypertension: renal color duplex sonography



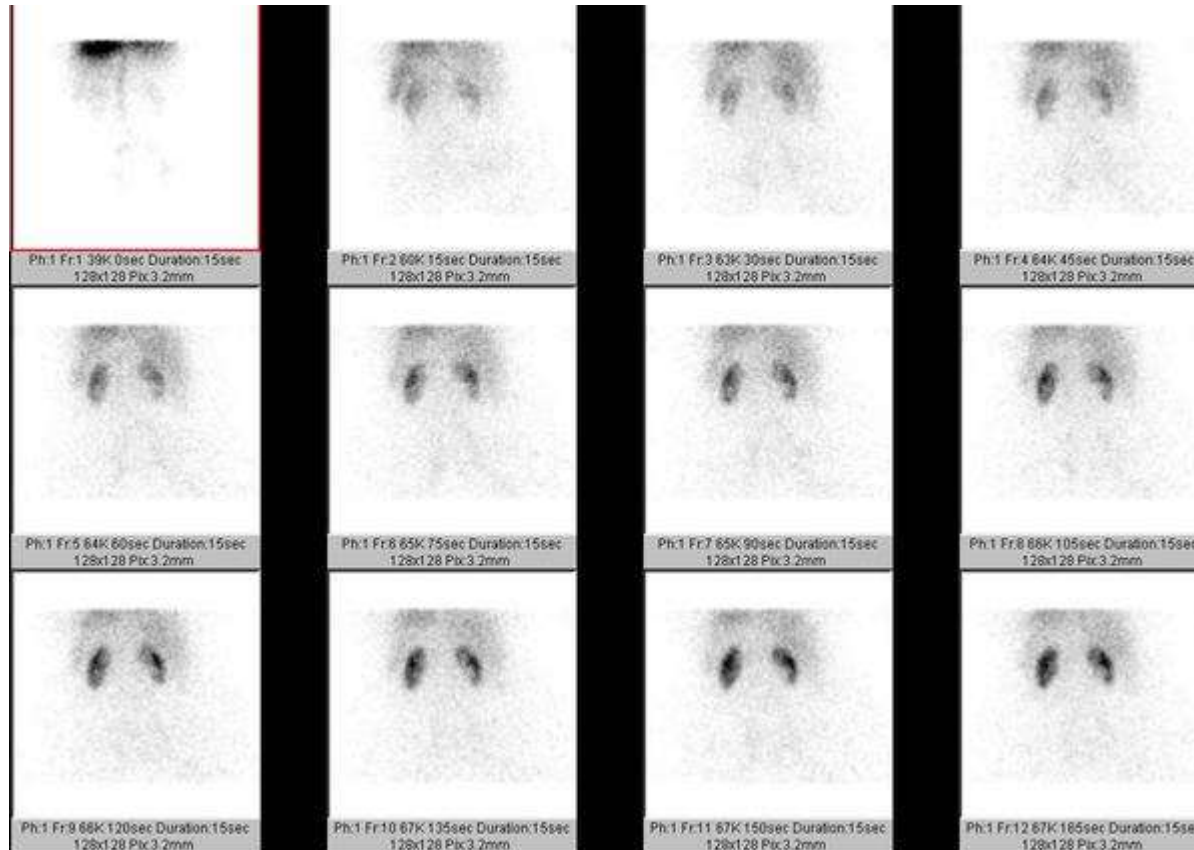
Spectral Doppler demonstrated high peak systolic velocity (6.27 m/s) at the right renal artery with hemodynamically significant stenosis

(Arterial) hypertension: renal magnetic resonance imaging



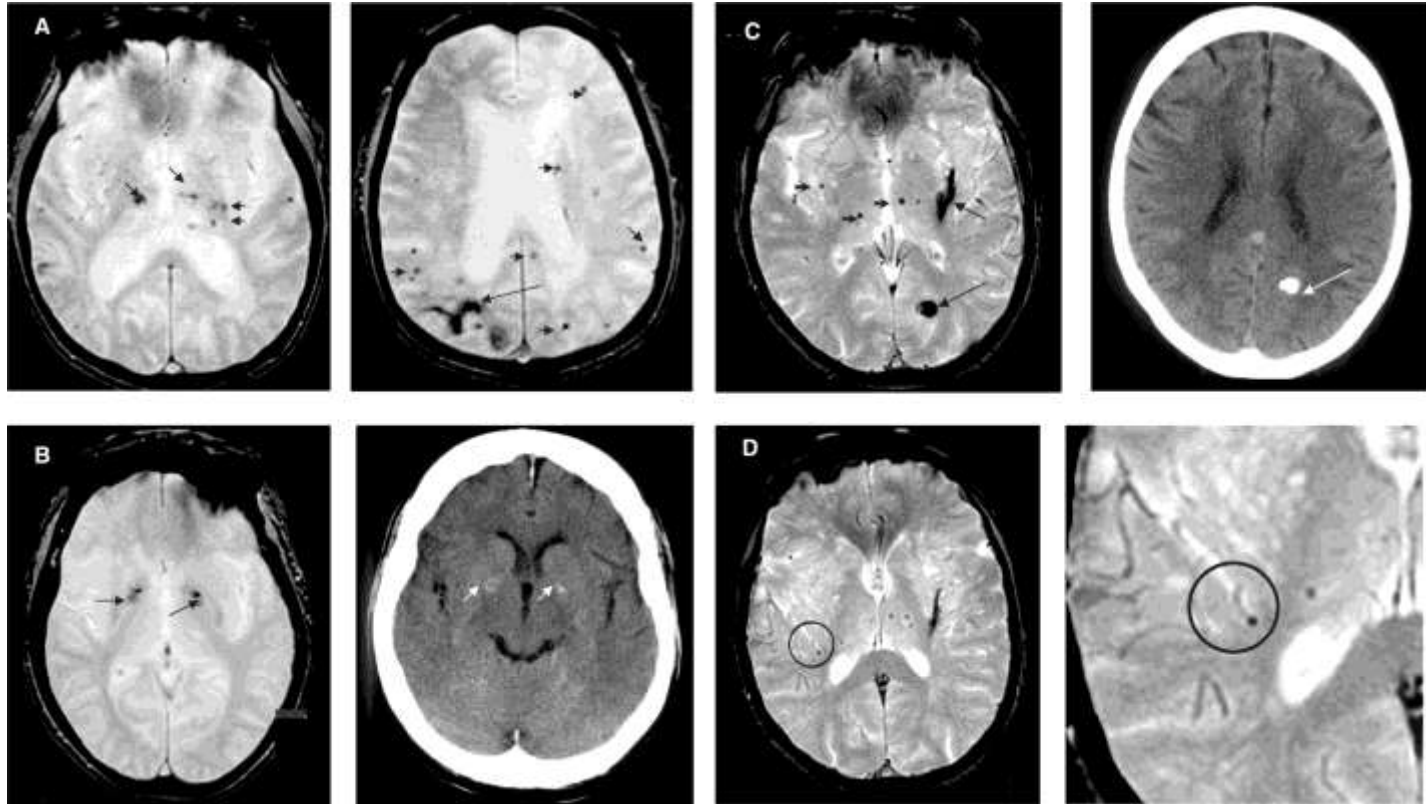
The stenosis at the right proximal renal artery.

(Arterial) hypertension: renal radionuclide imaging



Imaging of kidneys involves intravenous injection of tc mag3 (mercaptoacetyl triglycine) etc., and lying on table for hour or more while imaged by gamma camera

(Arterial) hypertension: brain magnetic resonance imaging



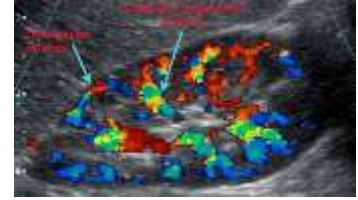
Brain microbleeds (BMBs) in arterial hypertension patient are seen as small, homogeneous, round foci of low signal intensity

(Arterial) hypertension: chest x-ray



The x-ray chest is suggesting a definite LV enlargement

(Arterial) hypertension: indication for renal ultrasonography



- If urinalysis detects albuminuria (proteinuria), cylindruria, or microhematuria or if serum creatinine is elevated (≥ 1.4 mg/dL [$124 \mu\text{mol/L}$] in men; ≥ 1.2 mg/dL [$106 \mu\text{mol/L}$] in women), renal ultrasonography to evaluate kidney size may provide useful information