Hypertension and the Kidney

Even with cautious blood pressure reduction using parenteral agents, altered blood flow autoregulation in the ischemic penumbra surrounding the infarct can lead to failure of autoregulation with worsening ischemia, extension of infarct, or exaggerated response to oral antihypertensives. Spontaneous resolution within the first week is observed in some cases.

FIGURE 8-29

Risks of antihypertensive therapy in acute cerebral infarction. Cerebral infarction results from partial or complete occlusion of an artery by an atherosclerotic plaque or embolization of atherothrombotic debris from a more proximal plaque. These atherothrombotic infarcts typically involve the cerebral cortex, cerebellar cortex, or pons; these infarcts are to be contrasted with hypertension-induced lipohyalinosis of the small penetrating cerebral end-arteries that is the principal cause of the small lacunar infarcts occurring in the basal ganglia, pons, thalamus, cerebellum, and deep hemispheric white matter. Hypertension occurs in up to 85% of patients with acute cerebral infarction, even in previously normotensive persons [40]. This early elevation of blood pressure probably represents a physiologic response to brain ischemia. Because of the known benefits of antihypertensive therapy with regard to stroke prevention, it previously had been assumed that acute reduction of blood pressure would also be of benefit in acute cerebral infarction. However, no evidence exists to suggest that acute reduction of blood pressure is beneficial in this setting. In fact, reports exist of worsening neurologic status, apparently precipitated by emergency treatment of hypertension in patients with cerebral infarction [41]. In the setting of acute cerebral infarction, hypertension tends to be very labile and exquisitely sensitive to hypertensive therapy. Thus, even modest doses of oral antihypertensive agents can lead to profound and devastating overshoot hypotension with extension of the infarct [42]. An additional rationale for not treating hypertension in the acute setting is based on evidence that local autoregulation of cerebral blood flow is impaired in the so-called ischemic penumbra, which surrounds the area of acute infarction [43]. Without intact autoregulation, the regional blood flow in this marginal zone of ischemia becomes critically dependent on the perfusion pressure. Thus, the presence of mild to moderate systemic hypertension may actually be protective, and acute reduction of blood pressure may cause a regional reduction in blood flow with extension of the infarct. Thus, in most cases of cerebral infarction it is prudent to allow the blood pressure to seek its own level during the first few days to weeks after the event. In most cases the hypertension tends to resolve spontaneously, without any specific therapy, over the first week as brain function recovers. When hypertension persists for more than 3 weeks after a completed infarction, reduction of the blood pressure into the normal range with oral antihypertensives is appropriate. Although benign neglect of mild to moderate hypertension is prudent in acute cerebral infarction, there may be certain indications for active treatment of blood pressure. When the diastolic blood pressure is sustained at over 130 mm Hg, cautious reduction of blood pressure into the ranges of 160 to 170 mm Hg systolic and 100 to 110 mm Hg diastolic may be appropriate. In stroke patients requiring anticoagulation therapy, moderate control of severe hypertension also should be considered. Cautious blood pressure reduction is indicated when stroke is accompanied by other hypertensive crises such as acute myocardial ischemia or acute hypertensive heart failure. Stroke caused by carotid occlusion by a proximal aortic dissection mandates aggressive blood pressure reduction into the normal range to halt the dissection process. In the setting of sudden severe hypertension, it may be difficult to distinguish hypertensive encephalopathy with focal neurologic findings from cerebral infarction. Because rapid reduction of blood pressure is lifesaving in patients with hypertensive encephalopathy, a cautious diagnostic trial of blood pressure reduction may be warranted (Fig. 8-21). If blood pressure reduction is deemed necessary in patients with acute cerebral infarction, treatment should be initiated using small doses of a short-acting parenteral agent such as sodium nitroprusside. Use of oral or sublingual nifedipine is associated with excessive risk of prolonged overshoot hypotension. Oral clonidine loading also is contraindicated because of the risk of hypotension and because sedative side effects interfere with the assessment of mental status.
Hypertensive crises from intracerebral hemorrhage

- Intracerebral hemorrhage
  - Reflex increase in blood pressure (Cushing's reflex)
  - Hypertension may help maintain blood flow in ischemic areas
  - Cerebral hyperperfusion with cerebral edema
  - Impairment of autoregulation of blood flow in ischemic area surrounding hematoma (shift of lower limit of autoregulation)
  - Increased risk of rebleeding (expansion of hematoma)
  - Sodium nitroprusside

Cautious blood pressure reduction by no more than 20% of presenting mean arterial pressure (intra-arterial and intracranial pressure monitoring to ensure adequate cerebral perfusion pressure)

**FIGURE 8-30**

Hypertensive crises due to intracerebral hemorrhage. Chronic hypertension is the major risk factor for intracerebral hemorrhage. The most common sites of hemorrhage are the small-diameter penetrating cerebral end-arteries in the basal ganglia, pons, thalamus, cerebellum, and deep hemispheric white matter. Lacunar infarcts arise from the same vessels and are similarly distributed. Intracerebral hemorrhage characteristically begins abruptly with headache and vomiting followed by steadily increasing focal neurologic deficits and alteration of consciousness [44]. More than 90% of hemorrhages rupture through brain parenchyma into the ventricles, producing bloody cerebrospinal fluid. Patients presenting with intracerebral hemorrhage are invariably hypertensive. In contrast to cerebral infarction, the hypertension does not tend to decrease spontaneously during the first week. The patient's condition worsens steadily over a period of minutes to days until either the neurologic deficit stabilizes or the patient dies. When death occurs, most often it is due to herniation caused by the expanding hematoma and surrounding edema. Treatment of hypertension in the setting of intracerebral hemorrhage is controversial. An increase in intracranial pressure accompanied by a reflex increase in systemic blood pressure almost always occurs. Because cerebral perfusion pressure is a function of the difference between arterial pressure and intracranial pressure, reduction of blood pressure could compromise cerebral perfusion. Moreover, as in cerebral infarction, autoregulation is impaired in the area of marginal ischemia surrounding the hemorrhage. In contrast, cerebral vasogenic edema may be exacerbated by hypertension. Moreover, hypertension may increase the risk of rebleeding with expansion of the hematoma. Thus, in deciding to treat hypertension in the setting of intracerebral hemorrhage, a precarious balance must be struck between beneficial reduction in cerebral edema on the one hand, and deleterious reduction of cerebral blood flow on the other. Studies have shown that the lower limit of autoregulation after intracerebral hemorrhage is approximately 80% of the initial blood pressure; therefore, a 20% decrease in mean arterial pressure should be considered the maximal goal of blood pressure reduction during the acute stage [45]. Antihypertensive therapy should be undertaken only in conjunction with intracranial and intra-arterial pressure monitoring to allow for assessment of cerebral perfusion pressure. The short duration of action of nitroprusside makes its use preferable over other agents with a longer duration of action and the risk of sustained overshoot hypotension, despite the theoretic concern that nitroprusside treatment could lead to an increase in intracranial pressure by way of dilation of cerebral veins and arteries.
Hypertensive crisis with pheochromocytoma. In most patients, pheochromocytoma causes sustained hypertension that sometimes becomes malignant as evidenced by the presence of hypertensive neuroretinopathy. Paroxysmal hypertension is present in approximately 30% of patients. Spontaneous paroxysms consist of severe hypertension, headache, profuse diaphoresis, pallor, coldness of hands and feet, palpitations, and abdominal discomfort. Paroxysmal hypertension in pheochromocytoma represents a hypertensive crisis because it can lead to intracerebral hemorrhage, hypertensive encephalopathy, or acute hypertensive heart failure with pulmonary edema. Prompt control of the blood pressure is mandatory to prevent these life-threatening complications. Although the nonselective $\alpha$-blocker phentolamine often is cited as the treatment of choice for pheochromocytoma-related hypertensive crises, sodium nitroprusside is equally effective and easier to administer [46]. Only after blood pressure has been controlled with nitroprusside or phentolamine can intravenous $\beta$-blockers, such as esmolol, labetalol, or propranolol, be used to control tachycardia or arrhythmias. After resolution of the hypertensive crisis, oral antihypertensive agents should be instituted as the parenteral agents are weaned. The nonselective $\alpha$-blocker phentolamine usually is administered orally for 1 to 2 weeks before elective surgery. After adequate $\alpha$-blockade is achieved, based on the presence of moderate orthostatic hypotension, oral $\beta$-blocker therapy can be initiated as needed to control tachycardia. Oral or intravenous $\beta$-blockers should never be administered before adequate $\alpha$-blockade. Doing so can precipitate a hypertensive crisis as the result of intense $\alpha$-adrenergic vasoconstriction that is no longer opposed by $\beta$-adrenergic vasodilatory stimuli. Careful attention to volume status also is mandatory in the preoperative period. Catecholamine-induced hypertension induces a pressure natriuresis with volume depletion. Moreover, alleviation of the chronic state of vasoconstriction by $\alpha$-blockade results in increases in both arterial and venous capacitances. Preoperative volume expansion, guided by measurement of central venous pressure or wedge pressure often is advocated to reduce the risk of intraoperative hypotension [47]. During surgery, rapid and wide fluctuations in blood pressure should be anticipated. Careful intraoperative monitoring of intra-arterial pressure, cardiac output, wedge pressure, and systemic vascular resistance is mandatory to manage the rapid swings in blood pressure. Despite adequate preoperative $\alpha$-blockade with phenoxybenzamine, severe hypertension can occur during intubation or intraoperatively as a result of catecholamine release during tumor manipulation. Sodium nitroprusside is the treatment of choice for controlling acute hypertension owing to pheochromocytoma during surgery. At the opposite end of the spectrum, profound intraoperative hypotension can occur. Hypotension or even frank shock can supervene after isolation of tumor venous drainage from the circulation, with resultant abrupt decrease in circulating catecholamine levels. Volume expansion is the treatment of choice for intraoperative and postoperative hypotension [46]. Pressors only should be employed when hypotension is unresponsive to volume repletion.