Chapter 112

Cerebral Venous Thrombosis

Gretchen E. Tietjen

DEFINITION OF CEREBRAL VENOUS THROMBOSIS

International Headache Society (IHS) code and diagnosis: 6.6 Cerebral venous thrombosis

World Health Organization (WHO) code and diagnosis: G 44.810 Headache associated with other vascular disorders

Short description: Headache is the most frequent symptom (present in up to 90%), and often with unilateral location. The temporal course is most often progressive, but it has also been reported to have a thunderclap presentation. The pain may be severe, and in the vast majority of cases there are associated focal symptoms (neurologic deficits or partial seizures) and/or signs of increased intracranial pressure (papilledema, diplopia, encephalopathy). After diagnosis, best achieved with magnetic resonance imaging (MRI) and MR angiography (MRA) or venography (MRV), standard evaluation should include routine laboratory studies and a hypercoagulable profile to evaluate for a prothrombotic state. Women on oral contraceptive pills and during pregnancy and the puerperium are at particular risk. Heparin is the treatment of choice, as headache responds most definitively to resumption of venous flow. The prognosis is favorable in most cases and headaches rarely (10%) become chronic.

EPIDEMIOLOGY

In the absence of population-based epidemiologic studies, the incidence of cerebral venous thrombosis (CVT) is unknown. Decidedly less common than arterial stroke (32), autopsy studies have suggested that CVT accounts for up to 10% of deaths due to cerebrovascular disease (2). It is suspected that the true incidence of CVT may be higher than generally reported because of missed diagnosis given its varied presentation and a usually favorable prognosis.

All age groups may be affected by CVT—from the neonate (43) to the very old (78), although data from the International Study on Cerebral Vein Thrombosis found a mean age of 39 years, with women affected up to three times more frequently than men (18).

ANATOMY AND PATHOLOGY

The venous vascular bed contains 70 to 80% of cerebral blood volume. Superficial veins drain the cortex and subcortical regions and empty into the dural sinuses (sagittal, transverse, petrosal, and cavernous), and then into the internal jugular vein. Deep veins drain the periventricular regions, deep white matter, the thalami, the basal ganglia, and choroids plexus, emptying into the internal cerebral and great cerebral veins. The deep and superficial veins are connected through anastomotic channels. Pathologic findings in CVT vary depending on the site of thrombosis. The superior sagittal sinus (62%) and left (43%) or right (40%) transverse sinuses are involved most frequently (18). In about half of all cases, multiple sinuses are involved. Deep draining veins, which are involved in one tenth of reported CVT cases, are paired, and thrombosis may, on occasion, involve the thalami or basal ganglia, bilaterally. Hemorrhage, related to vessel rupture following thrombosis, occurs in 15 to 49% of patients (18,27,33) and, although usually in the territory of infarcted parenchyma, may also involve the subdural and subarachnoid regions (22,75). Increased intracranial pressure from dural sinus thromboses accounts for many of the associated signs and symptoms of this condition (6). Cerebellar vein thrombosis may lead to compression of the fourth ventricle and obstructive hydrocephalus.

PREDISPOSING CONDITIONS

Women of childbearing age are most commonly affected by CVT related to pregnancy, the puerperium, and due to use of oral contraceptive, and rarely, to hormone

P1: KWW/KKL P2: KWW/HCN QC: KWW/FLX T1: KWW
GRBT050-112 Olesen- 2057G GRBT050-Olesen-v6.cls August 18, 2005 15:55

TABLE 112-1 Cerebral Venous Thrombosis: Predisposing Conditions

Infective	Local	Regional infections: mastoiditis, sinusitis, otitis, dental
	General	Viral: Herpes, HIV, cytomegalovirus
		Bacterial: Septicemia, Endocarditis
		Fungal: *Cryptococcus*, aspergillosis
		Parasitic: Trichinosis, Malaria
Noninfective	Idiopathic	
	Local	Head trauma, neurosurgical procedures, foreign body (pacer, jugular venous catheter), solid brain tumor, other CNS disorders
	General	Hemodynamic: dehydration, CHF
		Cancer
		Prothrombotic conditions
		Pregnancy/puerperium
		Oral contraceptives
		Inflammatory: vasculitis/aPL and systemic disease, such as Behçet's, inflammatory bowel disease, systemic lupus erythematosus, and sarcoidosis

CHF, congestive heart failure; CMV, cytomegalovirus; NS, neurosurgical.

replacement therapy (13,17,19,46,57,65,71,74) (Table 112-1). Comparing different regions of the world, there is considerable variability among the incidence of these different reproductive-related CVT cases (17,71). Genetically determined thrombophilias predisposing to CVT include activated protein C resistance (subset: Factor V Leiden mutation); protein S, protein C, and antithrombin III deficiencies; the prothrombin gene mutation; and hyperhomocysteinemia (8,9,16,28,30,55,63,79,81,82). Acquired thrombocytosis, polycythemia, and antiphospholipid antibodies are also important CVT risk factors. Any of the prothrombotic risk factors may play a role, either in isolation or coupled to another predisposing risk factor. Therefore, a history of prior CVT or other venous thrombosis (deep venous thrombosis, pulmonary embolus) in a person with persistent headache should increase the level of suspicion for cerebral venous thrombosis (4,21,29,38,48). Cancer, especially adenocarcinomas, leukemias, and lymphomas, increase the risk of CVT through altered coagulation status (42,44). Lowered intravascular volume with dehydration, sepsis, or malnutrition plays a particularly important role in CVT, especially at the extremes of age (20,34,40,47). Injuries to the dural sinus wall related to trauma, surgery, and conditions that compress or invade the sinus (e.g., solid tumors) set the stage for CVT (52,61). Inflammatory conditions (e.g., ulcerative colitis, Crohn, Behçet) and infections, both intracranial and in structures adjacent to the dural sinuses (e.g., otitis media, mastoiditis, sinusitis), also increase the risk of CVT (5,20,51,55,59,67,72,77,82).

CLINICAL FEATURES

The IHS diagnostic criteria for cerebral venous thrombosis (Revised International Classification of Headache Disorders [ICHD-II]) are as follows:

A. Any new headache, with or without neurologic signs fulfilling criteria C and D.
B. Neuroimaging evidence of cerebral venous thrombosis.
C. Headache (and neurologic signs if present) develops in close temporal relationship to cerebral venous thrombosis.
D. Headache resolves within 1 month after appropriate treatment.

HEADACHE CHARACTERISTICS

Although CVT manifests as a wide spectrum of presentations (Table 112-2), headache is the most frequent symptom (occurring in over 80% of cases), often the inaugural one, and it may even occur in isolation (1,3,19,29). Headache may result from distension of pain-sensitive structures (veins and sinuses) or from increased intracranial pressure.

In general, there are no typical characteristics or temporal profile of CVT-related headache. The most suggestive feature is the presence of associated signs, as has been found in 95% of cases (1,3,10,19,26). Most often diffuse, headache of CVT can also be unilateral or localized. The headache of cavernous or lateral sinus thrombosis may be retro-orbital; ear pain may accompany lateral sinus thrombosis. Headache severity with CVT is highly variable, ranging from a mild sensation of heaviness to excruciating pain. Most frequently, the onset of headache is subacute (more than 48 hours but less than 30 days) and progressive, but it also can be sudden and thunderclaplike (28,53). The headache is mostly continuous but can be intermittent, particularly initially. It often responds, at least in part, to narcotic and nonnarcotic analgesics or acetazolamide.

TABLE 112-2 Cerebral Venous Thrombosis: Main Neurologic Signs and Symptoms (5)

Sign/Symptom	Incidence, $n = 624$(%)
Headache	555 (89%)
Papilledema	175 (28%)
Generalized seizures	187 (30%)
Focal seizures	125 (20%)
Mental status disorder	137 (30%)

P1: KWW/KKL P2: KWW/HCN QC: KWW/FLX T1: KWW
GRBT050-112 Olesen- 2057G GRBT050-Olesen-v6.cls August 18, 2005 15:55

HEADACHE WITH INTRACRANIAL HYPERTENSION

Headache related to intracranial hypertension following CVT is progressive over days or weeks and associated with bilateral papilledema, which may interfere with visual acuity and visual fields. Less frequently, there may be tinnitus, transient visual obscurations, and diplopia from pressure-related sixth-nerve palsy. This presentation, which mimics that of idiopathic intracranial hypertension (IIH), accounted for 40% of 150 patients in one series (12). Every patient with suspected IIH, based on elevated cerebrospinal fluid (CSF) manometry and normal computed tomography (CT) scan, should be evaluated with more sophisticated neuroimaging studies for CVT (1,14). In a prospective study of 24 consecutive patients presenting with all the characteristics of IIH, MRA disclosed CVT in 6 (25%) (76). In another series of patients with chronic daily headache, 10% were found to have CVT, half of whom had isolated intracranial hypertension without papilledema, further underscoring the need for maintaining a high index of suspicion for this condition (63).

HEADACHE WITH FOCAL SIGNS AND SYMPTOMS

This presentation occurs most frequently, accounting for roughly 75% of published cases, but it is a heterogeneous one, depending on the mode of onset of focal signs and symptoms, their location, and underlying pathology. Transient migrainelike visual symptoms have been described with thrombosis in the torcula herophili (60). With parenchymal infarction, acute cases simulate an arterial stroke, chronic ones simulate tumors, and subacute cases mimic abscess.

Cortical vein thrombosis may induce partial-onset seizures, which may be followed by postictal paresis. Thrombosis of the cavernous sinus, which is situated on either side of the sphenoid bone, may be associated with ipsilateral chemosis, proptosis, ophthalmoparesis (CN III, IV, and VI), and facial numbness (CN V). Unilateral ophthalmoparesis and hearing loss may accompany lateral sinus thrombosis (25).

HEADACHE WITH ENCEPHALOPATHY

Headache and subacute encephalopathy may occur with a gradual elevation of intracranial pressure, including from the development of obstructive hydrocephalus. Headache and acute onset coma or stupor, often with decerebrate posturing and extensor spasms, may occur with a bilateral thalamic infarct from thrombosis of the deep veins. Also, headache and sudden depression of mental status may be related to rupture of distended veins into the subarachnoid space (14,28).

UNUSUAL PRESENTATIONS

CVT rarely presents as a postural headache after lumbar puncture or epidural anesthesia mimicking a postdural puncture headache, a classic differential diagnosis during the postpartum period (14,28). Other unusual symptoms include psychiatric disturbances, akinetic mutism, cortical blindness, hypothermia, vertigo, and ataxia (39,41,58).

EVALUATION

Given the extremely variable presentations of CVT, one must maintain a high index of suspicion with any recent headache, regardless of its severity, location, and associated signs, particularly when there is an underlying condition known to increase the risk of venous thrombosis (Table 112-1). The best noninvasive diagnostic tool for suspected CVT is MRI, which is sensitive to thrombus formation (Fig. 112-1) and blood flow obstruction, as well as to the indirect signs of CVT, including infarcts, parenchymal edema, petechial hemorrhage, collateral venous network, and mastoiditis (7,30,49). Standard spin echo T1- and T2-weighted MRI demonstrates lack of expected signal flow void in the venous structure. At the early stages of thrombus formation (days 1 to 5), oxyhemoglobin in intact red blood cells results in the thrombus, appearing isointense on T1 and hypointense on T2. In the subacute stages (days 5 to 30), the thrombus becomes hyperintense, first on T1, then on T2, related to conversion of oxyhemoglobin to methemoglobin. This gradual conversion, which in the large sinuses occurs from the periphery

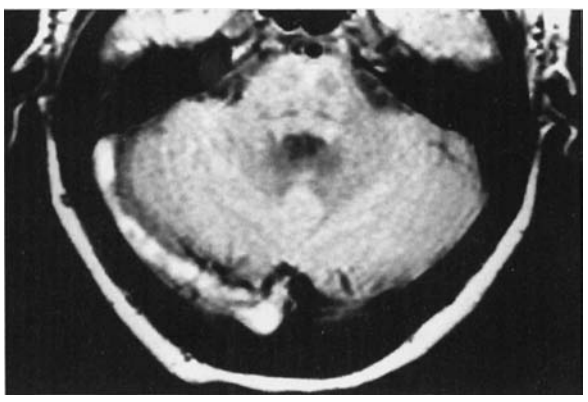

FIGURE 112-1. Magnetic resonance imaging in T1-weighted sequence: hyperintense signal in the right transverse sinus indicating thrombosis.

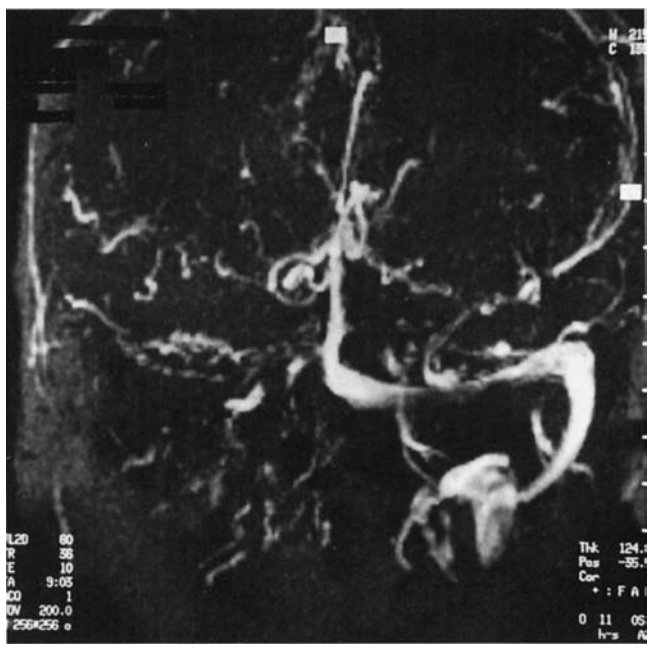

FIGURE 112-2. Flow sensitive magnetic resonance angiography of the same patient: lack of flow signal in the superior sagittal and right transverse sinus.

inward, accounts for the target sign of hypointense thrombus surrounded by a hyperintense rim. In the chronic stages (>30 days), the thrombus may become isointense on T1 and iso- to hyperintense on T2, and these changes may last for years. Gadolinium increases the sensitivity for detection of thrombosis within the sinus (the delta sign) and may also enhance cortical veins. Echo-planar T2* (susceptibility)-weighted MRI, which detects deoxyhemoglobin formation, may be useful in both the acute and subacute stages of thrombus formation (66). The resulting hypointense signal within the sinus may be helpful in differentiating sinus thrombosis from an absent or hypoplastic lateral sinus (a normal variant). Bright signal on diffusion-weighted MRI (DWI) may appear with venous infarctions, which are characterized by their multiplicity; subcortical, nonarterial location; and gyral enhancement. Due to restriction of water, the thrombus may appear bright on DWI (23). MRA may also show increased signal in the presence of venous sinus thrombosis (Fig. 112-2).

Noninvasive MRV is widely used in place of conventional techniques for diagnosing CVT, based on nonopacification and absence of flow void in venous structure (54,80). In concert with standard sequences, it may be more reliable than conventional angiography in differentiating occluded from hypoplastic structures and in detecting cavernous sinus thrombosis. Either angiographic technique allows for visualization of dilated, tortuous venous collaterals leading away from the occluded sinus. Conventional techniques may be more reliable in cases of isolated cortical vein thrombosis.

The role of CT scan, which is less sensitive for detection of CVT, is primarily to rule out other pathologies, such as tumor, arterial stroke, abscess, encephalitis, and subarachnoid hemorrhage. Indirect signs of CVT include visualization of venous infarcts, which often have a hemorrhagic component, and structural changes in the middle ear or mastoid. Although neither specific nor sensitive, the cord sign refers to the hyperdensity of fresh thrombus within the occluded sinus, seen on the unenhanced scan. The empty triangle sign (or delta sign) refers to the bright triangle surrounding a central hypodense core of the thrombus after contrast administration in the superior sagittal sinus (16,79). CT venography may be used to identify abnormal venous collaterals and filling defects within the sinuses. It is equivalent to MRV for CVT diagnosis, but less established (82).

After neuroimaging studies have been completed, CSF examination is a useful diagnostic tool when meningitis or encephalitis is suspected. It may also have therapeutic effects in those with symptoms of elevated intracerebral pressure and impending visual loss (12,15). One third of persons with CVT will have CSF pleocytosis from parameningeal irritation (28,49,51).

Routine laboratory studies (e.g., complete blood count, erythrocyte sedimentation rate, electrolytes, antinuclear antibodies, partial thromboplastin time [PTT], prothrombin time, serum protein electrophoresis) may support an underlying condition, which predisposes to CVT (Table 112-1). An evaluation for an occult hypercoagulable state should be performed, even in cases when another risk factor for CVT has been identified. This evaluation, which should be drawn prior to initiation of therapy, should include testing for acquired hypercoagulability (Table 112-1) (70). In the acute setting, D-dimer level of less than 500 ng/mL may be helpful in excluding CVT, although confirmatory studies are needed (50).

MANAGEMENT

Anticoagulation is a generally accepted therapy, and intravenous full-dose heparin treatment should be started as soon as possible (Recommendation Grade B or Guideline) (1,10,31,72). It is thought to be safe, even in patients with evidence of hemorrhagic conversion of a bland venous infarct. After an initial bolus of 3000 to 5000 IU, heparin per weight-based protocol should be given as a continuous intravenous drip until the PTT is at least doubled from pretreatment baseline. Subcutaneous low–molecular-weight heparin (nadroparin) use has been studied, and although safe was not clearly more effective than placebo (26). Treatment must be continued until remission of the acute stage of the disease (e.g., resolution of headache, remission or stable improvement of focal deficits, normal level of consciousness). At this stage, overlapping transition to oral anticoagulation with warfarin should be initiated, but

P1: KWW/KKL P2: KWW/HCN QC: KWW/FLX T1: KWW
GRBT050-112 Olesen- 2057G GRBT050-Olesen-v6.cls August 18, 2005 15:55

heparin therapy must be resumed if clinical deterioration occurs. Warfarin is continued for 3 to 6 months, and indefinitely, in cases of underlying coagulopathy.

In the rare patient with extensive sinus thrombosis whose clinical condition deteriorates despite optimal anticoagulation and symptomatic treatment, local thrombolysis with urokinase or recombinant tissue plasminogen activator (rt-PA) may be an option (36,44,67,68). The routine use of thrombolytes in patients with CVT is not recommended because of considerable experience and good results with heparin therapy as well as the risks of thrombolytic therapy and the lack of randomized trials for thrombolysis.

Management of patients with CVT further includes adequate control of seizures, which occur in 30 to 50% of all cases, with anticonvulsants. Reduction of an elevated intracranial pressure may be achieved with acetazolamide and diuretics. Other considerations for therapy include antibiotics, corticosteroids, and immunosuppression in those with autoimmune disorders and treatment of malignancy.

PROGNOSIS

The prognosis of CVT is unpredictable, although generally favorable. In recent studies, mortality rates as low as 4% have been reported and are generally less than 20% (35). The main causes of death are massive stroke, intercurrent complications (e.g., sepsis, uncontrolled seizures, pulmonary embolism), and underlying predisposing condition (carcinoma, leukemia, septicemia, paroxysmal nocturnal hemoglobinuria, heart failure). Poor clinical prognosticators include rapid onset of coma, focal neurologic deficits (including seizures), and extremes of age (34). Fortunately, most patients survive, with an excellent prognosis in terms of recovery of function. Up to 86% of persons have complete recovery (61). The most common residual symptoms include seizures and headaches, each in about 10% of cases (34). Multivariate predictors for death within 30 days were Glasgow Coma Scale score, age over 50, mental status disorder, hemiparesis, hemorrhage on admission, thrombosis of the deep venous system, CNS disorder, and underlying cancer (35).

REFERENCES

1. Ameri A, Bousser MG. Cerebral venous thrombosis. *Neurol Clin* 1992; 10(1):87–111.
2. Banerjee AK, Varma M, Vasista RK, et al. Cerebrovascular disease in north-west India: a study of necropsy material. *J Neurol Neurosurg Psychiatry* 1989;52(4):512–515.
3. Barinagarrementeria F, Cantu C, Aruruda VR. Aseptic cerebral venous thrombosis: proposed prognostic scale. *J Stroke Cerebrovasc Dis* 1992;2:34–39.
4. Belman AL, Roque CT, Ancona R, et al. Cerebral venous thrombosis in a child with iron deficiency anemia and thrombocytosis. *Stroke* 1990;21(3):488–493.
5. Ben Taarit C, Turki S, Ben Maiz H. [Neurological manifestations in Behçet's disease. Forty observations in a cohort of 300 patients]. *J Mal Vasc* 2002;27(2):77–81.
6. Bergui M, Bradac GB. Clinical picture of patients with cerebral venous thrombosis and patterns of dural sinus involvement. *Cerebrovasc Dis* 2003;16(3):211–216.
7. Bianchi D, Maeder P, Bogousslavsky J, et al. Diagnosis of cerebral venous thrombosis with routine magnetic resonance: an update. *Eur Neurol* 1998;40(4):179–190.
8. Biousse V, Conard J, Brouzes C, et al. Frequency of the 20210 G—>A mutation in the 3′-untranslated region of the prothrombin gene in 35 cases of cerebral venous thrombosis. *Stroke* 1998;29(7):1398–1400.
9. Boncoraglio G, Carriero MR, Chiapparini L, et al. Hyperhomocysteinemia and other thrombophilic risk factors in 26 patients with cerebral venous thrombosis. *Eur J Neurol* 2004;11(6):405–409.
10. Bousser MG. [Cerebral venous thrombosis. Report of 76 cases]. *J Mal Vasc* 1991;16(3):249–254.
11. Bousser MG, Chiras J, Bories J, et al. Cerebral venous thrombosis—a review of 38 cases. *Stroke* 1985;16(2):199–213.
12. Bousser MG, Einhaupl K. Cerebral venous thrombosis. In: Olesen J, Tfelt-Hansen P, Welch KM, ed. *The headaches*. New York: Raven Press Ltd., 1993:671–673.
13. Bousser MG, Kittner SJ. Oral contraceptives and stroke. *Cephalalgia* 2000;20(3):183–189.
14. Bousser MG, Russell RR. *Cerebral venous thrombosis: major problems in neurology*. London: W.B. Saunders, 1997.
15. Buonanno FS, Moody DM, Ball RM. CT scan findings in cerebral sinovenous occlusion. *Neurology* 1982;12:288–292.
16. Cakmak S, Derex L, Berruyer M, et al. Cerebral venous thrombosis: clinical outcome and systematic screening of prothrombotic factors. *Neurology* 2003;60(7):1175–1178.
17. Canhão P, Bousser MG, Barinagarrementeria F, et al. Predisposing conditions for cerebral vein and dural sinus thrombosis: http://www.iscvt.com.1-22-2003.
18. Canhão P, Ferro JM, Bousser MG, et al. International Study on Cerebral Vein Thrombosis (ISCVT): baseline data: http://www.iscvt.com/index.htm.1-22-2003.
19. Cantu C, Barinagarrementeria F. Cerebral venous thrombosis associated with pregnancy and puerperium. Review of 67 cases. *Stroke* 1993;24(12):1880–1884.
20. Carvalho KS, Bodensteiner JB, Connolly PJ, et al. Cerebral venous thrombosis in children. *J Child Neurol* 2001;16(8):574–580.
21. Christopher R, Nagaraja D, Dixit NS, et al. Anticardiolipin antibodies: a study in cerebral venous thrombosis. *Acta Neurol Scand* 1999;99(2): 121–124.
22. Chu K, Kang DW, Kim DE, et al. Cerebral venous thrombosis associated with tentorial subdural hematoma during oxymetholone therapy. *J Neurol Sci* 2001;185(1):27–30.
23. Chu K, Kang DW, Yoon BW, et al. Diffusion-weighted magnetic resonance in cerebral venous thrombosis. *Arch Neurol* 2001;58(10):1569–1576.
24. Ciccone A, Canhao P, Fal cao F, et al. Thrombolysis for cerebral uein and dural sinus thrombosis (Cochrane Review). In: The Cochrane Library, Issue 3, 2004; Chichester, UK: John Wiley & Sons, Ltd.
25. Crassard I, Biousse V, Bousser MG, et al. Hearing loss and headache revealing lateral sinus thrombosis in a patient with factor V Leiden mutation. *Stroke* 1997;28(4):876–878.
26. Daif A, Awada A, al Rajeh S, et al. Cerebral venous thrombosis in adults. A study of 40 cases from Saudi Arabia. *Stroke* 1995;26(7): 1193–1195.
27. De Bruijn SF, Stam J. Randomized, placebo-controlled trial of anticoagulant treatment with low-molecular-weight heparin for cerebral sinus thrombosis. *Stroke* 1999;30(3):484–488.
28. De Bruijn SF, Stam J, Kappelle LJ. Thunderclap headache as first symptom of cerebral venous sinus thrombosis. CVST Study Group. *Lancet* 1996;348(9042):1623–1625.
29. Deschiens MA, Conard J, Horellou MH, et al. Coagulation studies, factor V Leiden, and anticardiolipin antibodies in 40 cases of cerebral venous thrombosis. *Stroke* 1996;27(10):1724–1730.
30. Dormont D, Anxionnat R, Evrard S, et al. MRI in cerebral venous thrombosis. *J Neuroradiol* 1994;21(2):81–99.
31. Dulli DA, Luzzio CC, Williams EC, et al. Cerebral venous thrombosis and activated protein C resistance. *Stroke* 1996;27(10):1731–1733.

P1: KWW/KKL P2: KWW/HCN QC: KWW/FLX T1: KWW
GRBT050-112 Olesen- 2057G GRBT050-Olesen-v6.cls August 18, 2005 15:55

32. Einhaupl KM, Masuhr F. [Cerebral sinus and venous thrombosis]. *Ther Umsch* 1996;53(7):552–558.
33. Einhaupl KM, Villringer A, Meister W, et al. Heparin treatment in sinus venous thrombosis. *Lancet* 1991;338(8767):597–600.
34. Farstad H, Gaustad P, Kristiansen P, et al. Cerebral venous thrombosis and *Escherichia coli* infection in neonates. *Acta Paediatr* 2003;92(2):254–257.
35. Ferro JM, Lopes MG, Rosas MJ, et al. Long-term prognosis of cerebral vein and dural sinus thrombosis. Results of the VENOPORT study. *Cerebrovasc Dis* 2002;13(4):272–278.
36. Ferro JM, Stam J, Bousser MG, et al. The prognosis of acute cerebral vein and dural sinus thrombosis. ISCVT results. International Study on Cerebral Vein and Dural Sinus Thrombosis: 1-22-2003.
37. Frey JL, Muro GJ, McDougall CG, et al. Cerebral venous thrombosis: combined intrathrombus rtPA and intravenous heparin. *Stroke* 1999;30(3):489–494.
38. Fujimaki T, Matsutani M, Asai A, et al. Cerebral venous thrombosis due to high-altitude polycythemia. Case report. *J Neurosurg* 1986;64(1):148–150.
39. Fukutake T, Shimoe Y, Hattori T. Dizziness when eating: an unusual isolated presentation of cerebral venous thrombosis. *Intern Med* 2001;40(9):961–963.
40. Gates PC. Cerebral venous thrombosis. A retrospective review. *Aust N Z J Med* 1986;16(6):766–770.
41. Gladstone DJ, Silver FL, Willinsky RA, et al. Deep cerebral venous thrombosis: an illustrative case with reversible diencephalic dysfunction. *Can J Neurol Sci* 2001;28(2):159–162.
42. Hagner G, Iglesias-Rozas JR, Kolmel HW, et al. Hemorrhagic infarction of the basal ganglia. An unusual complication of acute leukemia. *Oncology* 1983;40(6):387–391.
43. Hanigan WC, Tracy PT, Tadros WS, et al. Neonatal cerebral venous thrombosis. *Pediatr Neurosci* 1988;14(4):177–183.
44. Hickey WF, Garnick MB, Henderson IC, et al. Primary cerebral venous thrombosis in patients with cancer—a rarely diagnosed paraneoplastic syndrome. Report of three cases and review of the literature. *Am J Med* 1982;73(5):740–750.
45. Horowitz M, Purdy P, Unwin H, et al. Treatment of dural sinus thrombosis using selective catheterization and urokinase. *Ann Neurol* 1995;38(1):58–67.
46. Jeng JS, Tang SC, Yip PK. Stroke in women of reproductive age: comparison between stroke related and unrelated to pregnancy. *J Neurol Sci* 2004;221(1–2):25–29.
47. Karabudak R, Caner H, Oztekin N, et al. Thrombosis of intracranial venous sinuses: aetiology, clinical findings and prognosis of 56 patients. *J Neurosurg Sci* 1990;34(2):117–121.
48. Kyritsis AP, Williams EC, Schutta HS. Cerebral venous thrombosis due to heparin-induced thrombocytopenia. *Stroke* 1990;21(10):1503–1505.
49. Lafitte F, Boukobza M, Guichard JP, et al. MRI and MRA for diagnosis and follow-up of cerebral venous thrombosis (CVT). *Clin Radiol* 1997;52(9):672–679.
50. Lalive PH, de Moerloose P, Lovblad K, et al. Is measurement of D-dimer useful in the diagnosis of cerebral venous thrombosis? *Neurology* 2003;61(8):1057–1060.
51. Lee TG, Yoon HJ, Ha CK, et al. Cerebral venous thrombosis associated with maxillary and ethmoid sinusitis—a case report. *J Korean Med Sci* 1995;10(5):388–392.
52. Link MJ, Schermerhorn TC, Fulgham JR, et al. Progressive neurological decline after partial spontaneous thrombosis of a Spetzler-Martin Grade 5 arteriovenous malformation in a patient with Leiden factor V mutation: management and outcome. *J Neurosurg* 2004;100(5):940–945.
53. Linn FH, Wijdicks EF. Causes and management of thunderclap headache: a comprehensive review. *Neurologist* 2002;8(5):279–289.
54. Lovblad KO, Schneider J, Bassetti C, et al. Fast contrast-enhanced MR whole-brain venography. *Neuroradiology* 2002;44(8):681–688.
55. Markowitz RL, Ment LR, Gryboski JD. Cerebral thromboembolic disease in pediatric and adult inflammatory bowel disease: case report and review of the literature. *J Pediatr Gastroenterol Nutr* 1989;8(3):413–420.
56. Martinelli I, Landi G, Merati G, et al. Factor V gene mutation is a risk factor for cerebral venous thrombosis. *Thromb Haemost* 1996;75(3):393–394.
57. Mas JL, Lamy C. Stroke in pregnancy and the puerperium. *J Neurol* 1998;245(6–7):305–313.
58. Monteiro ML, Hoyt WF, Imes RK. Puerperal cerebral blindness. Transient bilateral occipital involvement from presumed cerebral venous thrombosis. *Arch Neurol* 1984;41(12):1300–1301.
59. Musio F, Older SA, Jenkins T, et al. Case report: cerebral venous thrombosis as a manifestation of acute ulcerative colitis. *Am J Med Sci* 1993;305(1):28–35.
60. Newman DS, Levine SR, Curtis VL, et al. Migraine-like visual phenomena associated with cerebral venous thrombosis. *Headache* 1989;29(2):82–85.
61. Ozyurek E, Besbas N, Aslan D, et al. Trauma as a risk factor for thrombosis in children: a report of three cases. *Turk J Pediatr* 2003;45(2):167–169.
62. Preter M, Tzourio C, Ameri A, et al. Long-term prognosis in cerebral venous thrombosis. Follow-up of 77 patients. *Stroke* 1996;27(2):243–246.
63. Quattrone A, Bono F, Oliveri RL, et al. Cerebral venous thrombosis and isolated intracranial hypertension without papilledema in CDH. *Neurology* 2001;57(1):31–36.
64. Schluck E, Rodier G, Derouiche F, et al. [Thrombophilias associated with cerebral venous thrombosis]. *Rev Neurol (Paris)* 2002;158[5 Pt 1]:543–552.
65. Scoditti U, Buccino GP, Pini M, et al. Risk of acute cerebrovascular events related to low oestrogen oral contraceptive treatment. *Ital J Neurol Sci* 1998;19(1):15–19.
66. Selim M, Fink J, Linfante I, et al. Diagnosis of cerebral venous thrombosis with echo-planar T2*-weighted magnetic resonance imaging. *Arch Neurol* 2002;59(6):1021–1026.
67. Singh G, Sarkar S, Manoj K, et al. Cerebral venous thrombosis in acute inflammatory bowel disease. *Gut* 2004;53(2):161,206.
68. Smith AG, Cornblath WT, Deveikis JP. Local thrombolytic therapy in deep cerebral venous thrombosis. *Neurology* 1997;48(6):1613–1619.
69. Smith TP, Higashida RT, Barnwell SL, et al. Treatment of dural sinus thrombosis by urokinase infusion. *AJNR Am J Neuroradiol* 1994;15(5):801–807.
70. Spencer FA, Becker RC. Diagnosis and management of inherited and acquired thrombophilias. *J Thromb Thrombolysis* 1999;7(2):91–104.
71. Srinivasan K. Cerebral venous and arterial thrombosis in pregnancy and puerperium. A study of 135 patients. *Angiology* 1983;34(11):731–746.
72. Srivastava AK, Khanna N, Sardana V, et al. Cerebral venous thrombosis in ulcerative colitis. *Neurol India* 2002;50(2):215–217.
73. Stam J, de Bruijn S, deVeber G. Anticoagulation for cerebral sinus thrombosis. *Stroke* 2003;34(4):1054–1055.
74. Strachan R, Hughes D, Cowie R. Thrombosis of the straight sinus complicating hormone replacement therapy. *Br J Neurosurg* 1995;9(6):805–808.
75. Sztajzel R, Coeytaux A, Dehdashti AR, et al. Subarachnoid hemorrhage: a rare presentation of cerebral venous thrombosis. *Headache* 2001;41(9):889–892.
76. Tehindfazanarivelo AD, Evrard S, Schaison M. Prospective study of cerebral sinus venous thrombosis in patients presenting with benign intracranial hypertension. *Cerebrovasc Dis* 1992;2:22–27.
77. Topper R, Gartung C, Block F. [Neurologic complications in inflammatory bowel diseases]. *Nervenarzt* 2002;73(6):489–499.
78. Towbin A. The syndrome of latent cerebral venous thrombosis: its frequency and relation to age and congestive heart failure. *Stroke* 1973;4(3):419–430.
79. Virapongse C, Cazenave C, Quisling R, et al. The empty delta sign: frequency and significance in 76 cases of dural sinus thrombosis. *Radiology* 1987;162(3):779–785.
80. Voetsch B, Damasceno BP, Camargo EC, et al. Inherited thrombophilia as a risk factor for the development of ischemic stroke in young adults. *Thromb Haemost* 2000;83(2):229–233.
81. Vogl TJ, Bergman C, Villringer A, et al. Dural sinus thrombosis: value of venous MR angiography for diagnosis and follow-up. *AJR Am J Roentgenol* 1994;162:1191–1198.
82. Wasay M, Azeemuddin M. Neuroimaging of Cerebral Venous Thrombosis. *J Neuroimaging* 2005;15:118–128.
83. Wechsler B, Sbai A, Du-Boutin LT, et al. [Neurological manifestations of Behçet's disease]. *Rev Neurol (Paris)* 2002;158[10 Pt 1]:926–933.
84. Zuber M, Toulon P, Marnet L, et al. Factor V Leiden mutation in cerebral venous thrombosis. *Stroke* 1996;27(10):1721–1723.