Central Periodic Breathing During Sleep in Acute Ischemic Stroke

Dirk M. Hermann, MD; Massimiliano Siccoli, MD; Philip Kirov, MD; Matthias Gugger, MD; Claudio L. Bassetti, MD

Background and Purpose—It has been suggested that central periodic breathing during sleep (CPBS) may develop in unilateral supratentorial stroke without cardiopulmonary disease and disturbed consciousness. Not many data existed about such patients.

Methods—Of 31 patients with first-ever stroke, we report 3 patients with CPBS in the absence of cardiopulmonary and vigilance disturbances. Patient assessments included polysomnography, MRI and echocardiography. Nocturnal breathing was reassessed after 1 to 3 months.

Results—The patients had ischemic strokes in the left cingulate cortex, left insula and right paramedian thalamus. They were fully conscious when submitted to sleep recordings and lacked overt cardiovascular dysfunctions (ejection fractions = 67%, 48%, 65%). CPBS was present during 18% to 24% of sleep. In all patients, breathing improved during stroke recovery.

Conclusions—CPBS may be present in strokes involving autonomic (insula) and volitional (cingulate cortex, thalamus) respiratory networks. As such, CPBS partly resolves within weeks. (Stroke. 2007;38:1082-1084.)

Key Words: acute stroke ■ Cheyne-Stokes breathing ■ pathobiology ■ sleep ■ sleep apnea ■ sleep-disordered breathing ■ stroke

Central periodic breathing (CPB) is characterized by cyclic fluctuations in breathing drive, hyperpneas alternating with apneas or hypopneas in a gradual waxing-and-waning fashion.1 CPB most frequently results from congestive heart failure (≈50% with CPB).2 The oscillatory respiration in classic CPB (ie, Cheyne-Stokes breathing) results from an overshooting responsiveness of CO2 chemoreceptors, evoked by an elevated sympathetic activity and increased circulation time.3 CPB has also been found in neurological disorders mainly after bilateral strokes associated with disturbed consciousness.4 More recently, CPB during sleep (CPBS) has furthermore been described in unilateral stroke with preserved vigilance.5,6 Clinical studies reported variable CPBS prevalence in acute stroke patients,5–7 failing however to identify relationships between stroke localization and CPBS. From a prospective series of 31 patients with clinical first-ever stroke, we report 3 patients with probable neurogenic CPBS.

Materials and Methods
Neurological examinations were performed in all patients (20 males, 11 females; 50±13 years) on arrival at the Inselspital Berne. MRI (1.5T Siemens Magnetom) including diffusion-weighted images (DWI), duplex sonography and transesophageal echocardiography were performed. Polysomnography and respirography were recorded in the first 10 (mean 4.6±2.5) poststroke days (the latter with Autoset), and analyzed according to standard criteria.5 CPBS was defined as ≥3 cycles of crescendo-decrescendo breathing associated with ≥50% reduction in nasal airflow for ≥10 seconds.1

Results
Seventeen of 31 patients exhibited cortical (2 insular), 6 combined cortical-subcortical, 6 subcortical and 2 thalamic infarcts (21 left-sided, 10 right-sided). Eighteen patients (58%) had sleep-disordered breathing (apnea-hypopnea-index [AHI] >10/h), 3 (9.7%) presenting as CPBS (all others: obstructive apneas). The 3 patients with CPBS did not exhibit breathing abnormalities during the day.

Patient Reports

Patient 1
This 49-year-old man was admitted because of sudden headache, dysarthria, vision disturbances and right-sided weakness. He had no vascular risk factors and no history or signs of cardiopulmonary disease. On admission the patient was fully conscious (National Institutes of Health Stroke Scale [NIHSS] = 7). On clinical examination, a mild anosognosia, gaze preference to the right, and right-sided facio-brachial hemiparesis were found. DWI revealed a 7x2 cm lesion in the left cingulate cortex (Figure 1a). Duplex sonography revealed small plaques in the carotid bifurcation.
Echocardiography (ejection fraction [EF]=67%) and chest x-ray were normal. Stroke etiology remained unclear.

Sleep history before stroke revealed rare snoring, without evidence for sleep apnea or in-hypersomnolence (Epworth Sleepiness Score [ESS]=9, body mass index [BMI]=28 kg/m²). After stroke the patient complained of severe insomnia. During the first polysomnography, 4 days after stroke, he could fall asleep only after 10 mg zolpidem. Zolpidem was chosen because its muscle-relaxing effects are minimal.8 Total sleep time (TST) was reduced to 182 minutes (sleep efficiency [SE]=45%; stage 1=26%, stage 2=3%, stage 3/4=13%, REM=3%). AHI was 5/h, consisting of central apneas and hypopneas. There were 9 episodes of CPBS (Figure 2a), which persisted for a total of 36 minutes both during wakefulness (14 minutes) and stage 1 sleep (22 minutes; 18% of TST, 54 oxygen desaturations [SaO2 min=83%, baseline SaO2=95%], AHI [Autoset]=23/h).

After 3 months, the patient’s neurological deficits and insomnia had almost fully recovered (Barthel Index [BI]=100, modified Rankin Scale [mRS]=1). Polysomnography documented an improvement of sleep and breathing (TST=317 minutes; SE=68%, stage 1=24%, stage 2=21%, stage 3/4=11%, REM=12%; AHI=11/h). There were 6 CPBS episodes lasting 21 minutes in sleep stage 1 (13 minutes) and 2 (8 minutes; 7% TST, 15 desaturations [SaO2 min=89%, baseline SaO2=93%], AHI [Autoset]=0; Figure 2b).

**Patient 2**
This 52-year-old man was admitted with sudden right-sided weakness and speech disturbances. Besides arterial hypertension the patient had no history or signs of cardiopulmonary disease. On admission he was fully conscious (NIHSS=9). There were a right facio-brachio-cruveal hemiparesis, right gaze preference, and moderate dysphasia. DWI showed a hyperintense lesion in the left insula and gyrus angularis (Figure 1b). Cerebrovascular ultrasound showed small carotid plaques. Echocardiography revealed mild left ventricular hypokinesia (EF=48%). Chest x-ray was normal. Stroke etiology remained unclear.

Sleep history preceding stroke was positive for rare snoring, but not dyssomnia (ESS=8; BMI=29 kg/m²). After stroke the patient had no sleep-wake complaints. A first polysomnography 36 hours after stroke showed a TST of 446 minutes (SE=96%, stage 1=44%, stage 2=34%, stage 3/4=8%, REM=10%). AHI was 28/h (central apneas, hypopneas). There were 25 CPBS episodes lasting for 143 minutes in stage 1 (91 minutes), stage 2 (40 minutes), stage 3/4 (4 minutes) and REM (4 minutes) sleep (32% TST, 29 desaturations [SaO2 min=86%, baseline SaO2=95%], AHI [Autoset]=39/h).

One month later the patient’s neurological deficits had almost recovered (persistent mild dysphasia; BI=100, mRS=0). A second polysomnography showed a TST of 368 minutes (SE=96%, stage 1=30%, stage 2=45%, stage 3/4=11%, REM=10%). AHI was 25/h. There were 23 CPBS episodes lasting for 78 minutes during wakefulness (2 minutes), stage 1 (46 minutes) and stage 2 (30 minutes) sleep (21% TST, 20 desaturations [SaO2 min=88%, baseline SaO2=95%], AHI [Autoset]=22/h).

**Patient 3**
This 68-year-old man was admitted with sudden loss of consciousness followed by left-sided weakness. The patient had no risk factors and no history or signs of cardiopulmonary disease. Vigilance rapidly recovered within 1 hour. The patient exhibited left facio-brachio-cruveal hemiparesis with left-sided sensory loss, vertical gaze palsy and dysarthria...
(NIHSS = 12). DWI showed a hyperintense lesion in the right paramedian thalamus (Figure 1c). Duplex sonography, echocardiography (EF = 65%) and chest x-ray were normal. Stroke etiology remained unclear.

Sleep history preceding stroke was positive for snoring, nocturnal sleep apneas and mild daytime sleepiness (ESS = 12; BMI = 26 kg/m²). After stroke, the patient did not have new sleep-wake complaints. A first polysomnography 48 hours after stroke showed a TST of 406 minutes (SE = 91%, stage 1 = 46%, stage 2 = 35%, stage 3/4 = 0%, REM = 10%). AHI was 25/h (central apneas, hypopneas). There were 16 CPBS episodes lasting over 99 minutes during stage 1 (92 minutes) and stage 2 (7 minutes) sleep (24% TST, 40 desaturations [SaO₂ min = 89%, baseline SaO₂ = 95%], AHI [Autoset] = 28/h).

Three months later the patient’s neurological deficits had normalized (BI = 100, mRS = 0). A second polysomnography could not be recorded. Follow-up respirography revealed breathing improvement (AHI [Autoset] = 10/h).

**Discussion**

Of 31 patients with clinical first-ever stroke, we report 3 patients with distinct brain lesions involving autonomic (insula²) and volitional (supplementary motor cortex, thalamus¹⁰) respiratory centers probably exhibiting neurogenic CPBS. We suggest that the disruption of respiratory networks was responsible for the breathing abnormalities noticed.

CPBS has already been described after unilateral stroke in the absence of vigilance disturbances. Thus, 17 of 32 acute stroke patients monitored by abdominal wall motion and oxygen saturation measurements revealed CPBS.⁴ Unfortunately, breathing assessments did not include nasal flow recordings,⁴ precluding the possibility to differentiate CPBS from other forms of sleep-disordered breathing. Recent reports confirmed that CPBS may indeed be found in stroke patients with preserved consciousness,⁵⁻⁷ although at lower frequency. Detailed analyses of stroke topography did not exist.

Our patients almost exclusively exhibited central apneas. Thus, breathing abnormalities were unrelated to obstructive sleep apnea. Our patients lacked consciousness disturbances and overt cardiopulmonary disease. Echocardiographies revealed mild abnormalities only in the patient with insular stroke (EF = 48%) and normal cardiac function in the other patients (EF = 67% and 65%). This confirms that cardiac dysfunction is not mandatory. CPBS spontaneously improved within 1 to 3 months, indicating that respiratory disturbances are at least partly reversible.

From 31 patients, one patient with insular and one with thalamic stroke did not exhibit CPBS. It is conceivable that aspects of stroke extension influenced whether CPBS occurred. In the insula, sympathetic and parasympathetic centers are found in close vicinity.⁹ In the thalamus, the degree of reticular thalamic injury should influence whether CPBS develops.⁴⁰ Further efforts are needed to characterize more precisely topographical aspects of breathing abnormalities and their impact on stroke outcome.

**Disclosures**

None.

**References**

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