Case Report

Reversible Cerebral Vasoconstriction Syndrome with Increased Intracranial Pressure, Probably Related to Altitude Changes and Windy Winter Travelling

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Reversible cerebral vasoconstriction syndrome (RCVS) has reversible multifocal narrowing of the cerebral arteries. Respiratory alkalosis in high altitude studies cause impairment of the central nervous system, presumably by cerebral vasoconstriction. A 54 year-old woman presented with a 1-week of throbbing headache around her forehead while travelling in moderately high altitude, during a windy winter. Sudden severe headache had progressed and developed bilateral lower visual fields defect along with mild weakness of her right leg on the next day. Magnetic resonance (MR) imaging revealed acute ischemic process at both occipital, parasagittal left parietal and right frontal area. MR venography was negative but MR angiography showed multifocal narrowing of both anterior and posterior circulations. Lumbar puncture revealed the opening pressure of 240 mmH_2O but normal CSF profiles. Blood tests, including complete blood count, protein C, protein S, antithrombin III, high-sensitivity C-reactive protein, immunologic and antibody profiles were normal. Dexamethasone and low-molecular weight heparin were given because the intracranial vasculitis and cerebral venous thrombosis could not be ruled out. Visual fields and right leg problems had fully recovered on the second day and second week respectively. Prednisolone was discontinued at the fourth week. MR imaging and MR angiography were repeated in the sixteenth week and revealed old infarction at the left posterior parietal area but narrowing segment of arterial systems were no longer seen. There were a few previous reported cases of RCVS in Asian counties. The authors proposed that altitude changes from travelling to the moderately high altitude and cold windy winter weather were the predisposing factors for the attack of RCVS.

Keywords: *Reversible cerebral vasoconstriction syndrome, Altitude, Cold, Increased intracranial pressure, Asian*

J Med Assoc Thai 2011; 94 (5): 622-8
Full text. e-Journal: *http://www.mat.or.th/journal*

Reversible cerebral vasoconstriction syndrome (RCVS)[1,2] is characterized by multifocal narrowing of the cerebral arteries that would be completely resolved within days to weeks. Patients often present with acute onset of severe headache with or without neurologic signs and symptoms. RCVS can occur without identifiable cause and associated condition (use of vasoactive drugs, endocrine factors; hypercalcemia, pheochromocytoma, neurosurgical trauma, or uncontrolled hypertension). Many reports of different terminology would probably be the same or a closely related condition, *e.g.*, migrainous vasospasm or migraine angiitis[3], drug-induced cerebral arteritis or angiopathy, post partum angiopathy, Call-Fleming syndrome[4], thunderclap headache[5,6], and benign angiopathy of the central nervous system (BACNS). The term BACNS may indicates that the clinical-angiographic features overlap with primary angiitis of the central nervous system (PACNS)[7,8], but BACNS is likely to have normal or mildly abnormal cerebrospinal fluid (CSF) findings and are reversible after less intensive treatment[9,10]. High altitude studies showed severe respiratory alkalosis caused by hyperventilation, failing to maintain the minimum required alveolar P_{O2} in decreasing barometric pressure. Furthermore, they revealed significant abnormalities of motor coordination. Those persisted for more than 12 months after returning to sea level. They also revealed significant central nervous system impairment, presumably because of severe cerebral vasoconstriction[11]. (Central nervous system impairment caused

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by prolonged hyperventilation can occur both in low P_{O2} high altitude as well as in normal P_{O2} sea level prolonged anesthesia in coronary bypass procedures). Tourists who travel to high altitude with rapid ascent[12,13] could have a common acute mountain sickness, or more serious syndromes from decreasing barometric pressure, a high altitude cerebral edema, and high altitude pulmonary edema. Rapid ascent to high altitude and respiratory alkalosis in decreasing barometric pressure were presumed to have caused RCVS in the present case.

Case Report

A 54-year-old Thai woman presented with 1-week history of throbbing headache. The symptom began within the first two days she had travelled to a Zhangjiajie scenic spot, a moderately high altitude and windy atmosphere during the winter in China. The headache occurred around her forehead and referred to the vertex. Cleansing her face with cold water or coughing made the headache worse. Sometimes the symptoms relieved spontaneously but remaining dull aching. This headache pattern had persisted for a week until throbbing headache suddenly progressed and became severe, which caused vomiting and brought her to the hospital. Physical examination revealed a rising blood pressure of 160/80. Both optic fundi and other neurological signs were normal. Computed tomography (CT) of the brain was unremarkable. On the next day, her headache had partially resolved but she still had a minimal discomfort at the vertex. Her blood pressure returned to normal. She appreciated slight weakness at her right leg when she walked. Moreover, she could not see the food tray put on the level of her trunk even though she could see the face of the person standing in front of her, likely she also developed bilateral lower visual fields defect. Magnetic resonance (MR) imaging of the brain revealed high signal intensity lesions at both occipital lobes, parasagittal left parietal lobe and right frontal lobe in T2 weighted/FLAIR sequences and restricted diffusion on DWI without enhancement. These findings were likely to be an acute ischemia. Unenhanced MR venography was negative but MR angiography showed multifocal irregular narrowing at basal arteries of both anterior and posterior circulations (Fig. 1A). Lumbar puncture revealed opening pressure of 240 mmH_2O but normal CSF profiles. The provisional diagnosis of cerebral venous thrombosis was made. A weight adjusted twice-daily dose of low-molecular weight heparin was prescribed along with dexamethasone, regarding intracranial vasculitis. Her visual fields defect was fully recovered on the second day of treatment, but mild weakness of her right leg persisted. On the fourth day, subsequent MR imaging of the brain (Fig. 2) revealed increased areas of acute infarctions at the subcortical area of the right occipital lobe, left occipital area, left parasagittal high parietal lobe and bilateral centrum semiovalae with slightly increased vascularity of the brain after contrast material injection. Surprisingly, her right leg strength was better.

From her history, she denies having a migraine headache in the past. Her brother died from systemic lupus erythematosus. Blood tests, including complete blood count and multiple chemistry profiles, protein C, protein S, antithrombin III, high-sensitivity C-reactive protein, antinuclear antibodies, lupus anticoagulant,

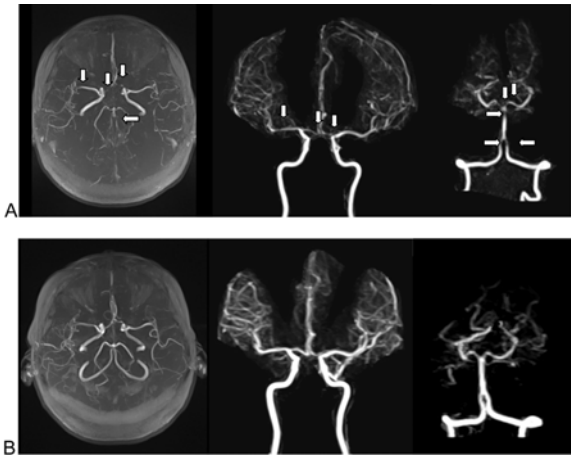

Fig. 1 Comparing unenhanced maximum intensity projection (MIP) image, gadolinium-enhanced MR angiography revealed multifocal irregular narrowing (arrow) at basal arteries of both anterior and posterior circulations on the fourth day of admission (A) and resolution of the narrowing segments in the sixteenth week follow-up (B)

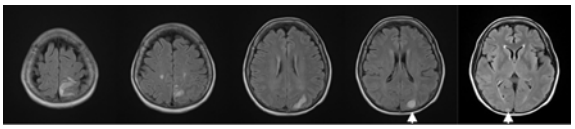

Fig. 2 MR imaging of the brain on the fourth day of admission, FLAIR sequence revealed high signal intensity lesions at left and right occipital lobes (arrow head), left parasagittal high parietal lobe and bilateral centrum semiovalae

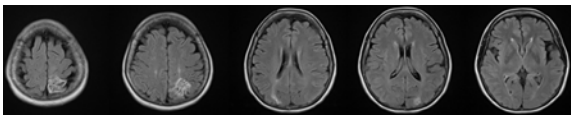

Fig. 3 MR imaging of the brain in the sixteenth week follow-up, FLAIR sequence revealed high signal intensity lesion at left parietal lobe

anticardiolipin antibody, C3 and C4 complements and antineutrophil cytoplasmic antibodies were within normal limits. Erythrocyte sedimentation rate was 23 mm/hr and LDL-cholesterol was 173 mg/dl. Subsequent result of CSF cytology was negative.

Warfarin and prednisolone were prescribed during discharge. She could walk normally in the second-week clinical follow-up. Prednisolone was discontinued after the fourth-week therapy due to the ocular side effect of central serous chorioretinopathy on her left eye.

MR imaging of the brain (Fig. 3) and MR angiography (Fig. 1B), which were repeated in the sixteenth-week follow-up, revealed old infarction at the left posterior parietal area. This time, there was no narrowing segment of both anterior and posterior circulations, which had been shown on the previous MR angiography. Reversible cerebral vasoconstriction syndrome was then diagnosed.

Discussion

This patient presented with subacute throbbing and sudden worsening severe headache, which was likely to be defined as thunderclap headache. Her MR imaging of the brain showed bilateral multifocal cortical hemispheric area of acute ischemia and initial MR angiography showed irregular narrowing of both anterior and posterior circulations. Focal neurological deficits gradually recovered shortly after their onsets and a few days of therapy. At the sixteenth-week follow-up, MR imaging of the brain showed partial reperfusion of ischemic areas and residual infarction. MR angiography showed complete resolution of all narrowing segments. Most likely, it was RCVS.

The characteristic of RCVS comprises of sudden severe headaches with or without associated neurological deficits. It can be complicated by ischemic or hemorrhagic strokes. Transient hypertension is common. Angiographic finding of cerebral artery narrowing could not be differentiated from other diseases such as intracranial atherosclerosis and cerebral vasculitis. Resolution of headaches and vasoconstriction in RCVS occur over a period of days to weeks[1]. The resolution of the present case had started since the second day of treatment, which might be due to the effect of medications or self-limited, reversible symptoms. Increasing area of MR imaging lesions but improving muscle strength of the right leg on the fourth day of treatment, which might indicate that there were both cytotoxic and vasogenic edema, and the latter could explain a reciprocal relation between clinical sign and radiographic findings. Some resolution of MR imaging lesions and complete resolution of MR angiography narrowing segments of the sixteenth-week follow up, indicated an area of decreased cerebral blood flow and received reperfusion[14]. In addition, residual infarction indicated an area of decreased cerebral blood volume and infarction core.

The cause and pathophysiology remain to be cleared in the future. The attack of RCVS may be provoked or triggered by various exogenous or endogenous factors such as drugs, trauma, uncontrolled hypertension, endocrine, immunologic, and biochemical factors. The proposed predisposing factor is the effect of respiratory alkalosis caused by high altitude[11] while travelling in windy and cold[6] weather, leading to vasoconstriction[15]. Although the diagnostic criteria

Table 1. Conditions associated with reversible cerebral vasoconstriction syndromes from literature reviews[1,6,20], case series[21,24] and case reports[22,23]

- Postpartum
- Exposure to vasoactive substances, drugs, including Chinese herbal medicine[22] (containing ephedara herba as a nasal decongestant)
- Catecholamine secreting tumours
- Exposure to immunosuppressants, blood products or blood transfusion
- Extra or intracranial large artery disorders
- Head trauma, neurosurgical procedures
- Physical activities[6]; sexual activity and orgasm, sneeze, sit ups, push-ups, skipping rope, swimming, snorkeling, straining, bending and exposure to cold, deep diving in a swimming pool[23], bathing[24]

Table 2. Summary of clinical characteristics, precipitating factors, investigation findings among Asian reported cases

Reference	Precipitating factors	Patient's age/sex	Headache history	Location of pain	Transient elevated blood pressure	Erythrocyte sedimentation rate	Cerebrospinal fluid study	Vascular studies	Time before remission of headache
25	Bathing	Hong Kong (6 cases) 47-67/F Japan (3 cases) 47-54/F Taiwan (4 cases) 32-53/F	Tension headache 2 reported cases	Frontal Bitemporal Vertex Left sided Neck Vertex radiation Occipital radiation	3 reported cases	Normal range 2 reported cases	Normal 4 reported cases Mild lymphocytic pleocytosis 1 reported case	Transient multisegmental vasoconstriction in MRA 1 reported case Transient diffuse vasospasm in cerebral angiography with residual small cerebellar infarction 1 reported case Transient increased flow velocity at left posterior cerebral artery 1 reported case	7 days to less than 3 months
26	Post partum Ecstacy use Orgasm	Taiwan 34/F	Not reported	Neck occipital and vertex radiation	Not reported	Not reported	Not reported	Segmental vasoconstriction in MRA Not have MRA follow-up	Less than 3 months
This reported case	Altitude changes Cold weather	Bangkok Thailand 54/F	No headache history	Frontal and vertex radiation	Transient elevated	Normal range	Normal CSF profiles but opening pressure of 240 mmH_2O	Transient multifocal vasoconstriction with residual small infarction	Less than 2 weeks

of RCVS have not been prospectively validated, the authors followed the possible criteria in literature review[1].

According to clinical syndromes with severe headache, isolated cerebral arteries involvement, normal CSF profiles, dramatic resolution of angiographic abnormalities, and clinical recovery, the differential diagnosis is likely to be BACNS[3,10]. Regarding steroid treatment, clinical response was rapid and there was angiographic resolution, which PACNS[8] could be ruled out.

Subacute with sudden worsening severe headache was also reported in cerebral venous thrombosis[16]. Other than the possible criteria for diagnosis of RCVS[1], this patient had elevated intracranial pressure together with bilateral multifocal cortical hemispheric area of acute ischemia, predominantly and confluent in posterior parietooccipital lobes. Those had been likely to be concomitant cerebral venous thrombosis. However, MR venography[17,18] did not elicit any abnormality, which made it unlikely to be this condition but needed to be closely monitored and reevaluated. However, early anticoagulant was prescribed in case of benign intracranial hypertension[19], which would probably be an initial presentation of cerebral venous thrombosis and prevent serious clinical consequence, a visual loss of benign intracranial hypertension itself. Together with or without cortical venous thrombosis[17], this might not be easily seen in MR venography. It may show only focal cortical lesions in the initial stage.

The increased intracranial pressure might be seen in high altitude cerebral edema and acute mountain sickness[12,13] in those who ascend rapidly to altitudes above about 3,000 meters, defined as a high altitude, without sufficient time to acclimatize. In the presented case, the patient travelled up to altitudes about 1,200 meters, which is not as high as to commonly produce an acute mountain sickness. In addition, MR imaging in this case did not show any diffuse brain swelling. This is an interesting point. Any RCVS with increased intracranial pressure cases and lowlanders who live at about sea level altitude, ascending rapidly to moderate to high altitude produce signs and symptoms of RCVS. However, the cause of increased intracranial pressure in the presented case was presumptive due to cerebral arteriolar vasodilatation, which compensated for any focal vasoconstriction of cerebral arteries.

The presented patient had been prescribed low-doses of glucocorticoid for one month. Treatment for RCVS is guided by observational data; brief courses of glucocorticoids have been reported with successful outcomes[10]. On the other hand, complication such as stroke has been reported among cerebral vasoconstriction cases[2].

Conclusion

The authors reported a case of RCVS who presented with sudden severe throbbing headache when returning from a trip in windy and cold weather in a moderately high altitude area. Normal CSF profiles and dramatic clinical recovery in a short period along with the resolution of narrowing segments in subsequence MR angiography were crucial clues to diagnose RCVS. Elevated intracranial pressure was observed in the present case. To the authors' knowledge, the presented case is the first case reported in Thailand and is among a few previous reported cases of RCVS in Asian counties (Table 2). This is also the first proposed case probably related to an altitude changes from travelling to a moderately high altitude, cold windy winter weather and concomitant with increased intracranial pressure at the time of diagnosis. The travelers from the lowland such as Thailand should be aware of this condition.

Potential conflicts of interest

None.

References

1. Calabrese LH, Dodick DW, Schwedt TJ, Singhal AB. Narrative review: reversible cerebral vasoconstriction syndromes. Ann Intern Med 2007; 146: 34-44.
2. Singhal AB. Cerebral vasoconstriction syndromes. Top Stroke Rehabil 2004; 11: 1-6.
3. Serdaru M, Chiras J, Cujas M, Lhermitte F. Isolated benign cerebral vasculitis or migrainous vasospasm? J Neurol Neurosurg Psychiatry 1984; 47: 73-6.
4. Call GK, Fleming MC, Sealfon S, Levine H, Kistler JP, Fisher CM. Reversible cerebral segmental vasoconstriction. Stroke 1988; 19: 1159-70.
5. Schwedt TJ, Matharu MS, Dodick DW. Thunderclap headache. Lancet Neurol 2006; 5: 621-31.
6. Valenca MM, Andrade-Valenca LP, Bordini CA, Speciali JG. Thunderclap headache attributed to reversible cerebral vasoconstriction: view and review. J Headache Pain 2008; 9: 277-88.
7. MacLaren K, Gillespie J, Shrestha S, Neary D,

Ballardie FW. Primary angiitis of the central nervous system: emerging variants. QJM 2005; 98: 643-54.
8. Salvarani C, Brown RD Jr, Calamia KT, Christianson TJ, Weigand SD, Miller DV, et al. Primary central nervous system vasculitis: analysis of 101 patients. Ann Neurol 2007; 62: 442-51.
9. Jolly M, Curran JJ, Ellman M. Benign angiopathy of the central nervous system. J Clin Rheumatol 2004; 10: 80-2.
10. Hajj-Ali RA, Furlan A, Abou-Chebel A, Calabrese LH. Benign angiopathy of the central nervous system: cohort of 16 patients with clinical course and long-term followup. Arthritis Rheum 2002; 47: 662-9.
11. West JB. Tolerance to severe hypoxia: lessons from Mt. Everest. Acta Anaesthesiol Scand Suppl 1990; 94: 18-23.
12. Hultgren HN. High altitude medical problems. West J Med 1979; 131: 8-23.
13. Imray C, Wright A, Subudhi A, Roach R. Acute mountain sickness: pathophysiology, prevention, and treatment. Prog Cardiovasc Dis 2010; 52: 467-84.
14. Suwanwela N, Koroshetz WJ. Acute ischemic stroke: overview of recent therapeutic developments. Annu Rev Med 2007; 58: 89-106.
15. Roggendorf W, Cervos-Navarro J. Ultrastructural characteristics of spasm in intracerebral arterioles. J Neurol Neurosurg Psychiatry 1982; 45: 120-5.
16. Agostoni E. Headache in cerebral venous thrombosis. Neurol Sci 2004; 25(Suppl 3): S206-10.
17. Leach JL, Fortuna RB, Jones BV, Gaskill-Shipley MF. Imaging of cerebral venous thrombosis: current techniques, spectrum of findings, and diagnostic pitfalls. Radiographics 2006; 26 (Suppl 1): S19-41.
18. Connor SE, Jarosz JM. Magnetic resonance imaging of cerebral venous sinus thrombosis. Clin Radiol 2002; 57: 449-61.
19. Agostoni E, Aliprandi A. Alterations in the cerebral venous circulation as a cause of headache. Neurol Sci 2009; 30(Suppl 1): S7-10.
20. Ducros A, Bousser MG. Reversible cerebral vasoconstriction syndrome. Pract Neurol 2009; 9: 256-67.
21. Ducros A, Boukobza M, Porcher R, Sarov M, Valade D, Bousser MG. The clinical and radiological spectrum of reversible cerebral vasoconstriction syndrome. A prospective series of 67 patients. Brain 2007; 130: 3091-101.
22. Ichiki M, Watanabe O, Okamoto Y, Ikeda K, Takashima H, Arimura K. A case of reversible cerebral vasoconstriction syndrome (RCVS) triggered by a Chinese herbal medicine. Rinsho Shinkeigaku 2008; 48: 267-70.
23. Kirton A, Diggle J, Hu W, Wirrell E. A pediatric case of reversible segmental cerebral vasoconstriction. Can J Neurol Sci 2006; 33: 250-3.
24. Wang SJ, Fuh JL, Wu ZA, Chen SP, Lirng JF. Bath-related thunderclap headache: a study of 21 consecutive patients. Cephalalgia 2008; 28: 524-30.
25. Mak W, Tsang KL, Tsoi TH, Au Yeung KM, Chan KH, Cheng TS, et al. Bath-related headache. Cephalalgia 2005; 25: 191-8.
26. Hu CM, Lin YJ, Fan YK, Chen SP, Lai TH. Isolated thunderclap headache during sex: Orgasmic headache or reversible cerebral vasoconstriction syndrome? J Clin Neurosci 2010; 17: 1349-51.

กลุ่มอาการหลอดเลือดสมองหดตัวชั่วคราวร่วมกับความดันในกะโหลกศีรษะสูง เหตุจากการขึ้นบรรยากาศชั้นสูงร่วมกับอากาศหนาวเย็น

ชัยธวัช เทียนวิบูลย์, สมพนธ์ บุณยคุปต์, อานนท์ พงศ์ธรกุลพานิช, สุรวุฒิ ปรีชานนท์

กลุ่มอาการหลอดเลือดสมองหดตัวชั่วคราวประกอบด้วย หลอดเลือดสมองหดตัว หลายแห่งซึ่งต่อมากลับคืนเป็นปกติ การเดินทางขึ้นที่สูงมีผลต่อสมดุลกรดด่างในร่างกาย การเสียสมดุลชนิดเป็นด่างโดยการหายใจ ทำให้เกิดหลอดเลือดสมองหดตัว คณะผู้นิพนธ์ได้รายงานผู้ป่วยหญิง อายุ 54 ปี มีอาการปวดศีรษะรุนแรงแบบตุ้บบริเวณหน้าผาก 1 สัปดาห์ ขณะเที่ยวที่สูงระดับปานกลาง ลมแรงในช่วงฤดูหนาว เกิดอาการปวดศีรษะรุนแรงขึ้นทันที วันต่อมาเสียความสามารถของการเห็น บริเวณครึ่งล่างของลานสายตาทั้งสองข้าง และขาขวาอ่อนแรง ตรวจเอกซเรย์สมองด้วยคลื่นแม่เหล็กไฟฟ้า พบเนื้อสมองขาดเลือดในระยะเฉียบพลันบริเวณกลีบสมองส่วนท้ายทอยทั้งสองข้าง พาริยทัลด้านซ้าย และกลีบสมองส่วนหน้าด้านขวา หลอดเลือดดำ สมองปกติ แต่พบหลอดเลือดแดงสมองตีบแคบลงหลายแห่ง พบทั้งหลอดเลือดสมองส่วนหน้าและหลัง ตรวจน้ำไขสันหลังพบความดันน้ำไขสันหลังสูง 240 มิลลิเมตรน้ำ แต่ผลตรวจทางห้องปฏิบัติการปกติ ผลตรวจเลือด เม็ดเลือดและเกล็ดเลือดปกติ โปรตีน ซี โปรตีน เอส แอนติทรอมบิน ทรี ซีอาร์พี และการตรวจทางวิทยาภูมิคุ้มกัน ทั้งหมดปกติ ผู้ป่วยได้รับเด็กซาเมธาโซน และเฮปพารินน้ำหนักโมเลกุลต่ำ เนื่องจากระยะแรก ยังไม่ทราบสาเหตุของโรค แยกโรคหลอดเลือดสมองอักเสบ และโรคหลอดเลือดดำสมองอุดตันไม่ได้ หลังจากนั้นอาการทางลานสายตาหายสนิทในสองวัน และอาการที่ขาขวามีแรงเป็นปกติในสองสัปดาห์ให้หยุดเพรดนิโซโลนในสัปดาห์ที่สี่ของการรักษา ตรวจเอกซเรย์ด้วยคลื่นแม่เหล็กไฟฟ้าซ้ำในสัปดาห์ที่สิบหก พบรอยโรคจากสมองขาดเลือด บริเวณพาริยทัลด้านซ้าย แต่ไม่พบการตีบแคบของหลอดเลือดแดงสมอง มีรายงานของกลุ่มอาการนี้ในประเทศแถบเอเชียน้อยราย ผู้ป่วยรายนี้สันนิษฐานว่ามีสาเหตุจากขึ้นบรรยากาศชั้นสูงร่วมกับอากาศหนาวเย็น