Central Hypoventilation Syndrome Complicated with Lateral Medullary Infarction after Endovascular Treatment of the Vertebral Artery Dissecting Aneurysm: A Case Report

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Lateral medullary infarction rarely leads to central hypoventilation syndrome (CHS). CHS is a life-threatening disorder characterized by hypoventilation during sleep. We report the first case of CHS as a complication of lateral medullary infarction after endovascular treatment. A 65-year-old man presented twice with severe headache. Computed tomography revealed subarachnoid hemorrhage and cerebral angiography showed a right vertebral dissecting aneurysm involving the posterior inferior cerebellar artery. After emergent endovascular patent artery occlusion, he developed Wallenberg syndrome and experienced apnea and a conscious disturbance episode due to CHS on postoperative days 6 and 16. Intensive respiratory care including intubation, tracheostomy, mechanical ventilation, and rehabilitation prevented subsequent recurrence of apnea and the CHS resolved completely. CHS after unilateral medullary infarction involving respiratory centers tends to occur in the acute and subacute phase and may be lethal without careful respiratory management.

Keywords: central hypoventilation syndrome, lateral medullary infarction, Wallenberg syndrome, vertebral artery dissecting aneurysm, internal trapping

Introduction

Wallenberg syndrome is rarely associated with central hypoventilation syndrome (CHS), also referred to as acquired Ondine's curse. Hypoventilation occurs in the acute and subacute phase following impairment of the medullary respiratory center. CHS affecting the ventral respiratory center may induce autonomic respiratory disorders during sleep in spite of maintaining voluntary respiration. We report this type of CHS complicating right lateral medullary infarction after endovascular patent artery occlusion for a right vertebral artery dissecting aneurysm.

Case Presentation

The patient was a 65-year-old man with hypertension and no history of respiratory disease. He presented twice with a severe headache on the day of admission and 2 weeks prior.

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Head computed tomography (CT) revealed a subarachnoid hemorrhage (SAH) that was dominant in the premedullary and prepontine cistern (Fig. 1A). Neurological examination on admission revealed nuchal stiffness and mild disorientation (Glasgow Coma Scale; GCS 14, Hunt and Kosnik grade 2, WFNS grade 2). CT angiography and digital subtraction angiography (DSA) showed the vertebral artery dissecting aneurysm (VAD) involving the right posterior inferior cerebellar artery (PICA) on the non-dominant side, which was located in the right vertebral artery (VA) from 13 to 33 mm proximal to the VA union. An aneurysmal dilatation was detected distal to the PICA bifurcation (Fig. 1B, 2A). Hematological examination revealed neither coagulopathy nor a hemostatic disorder.

Endovascular treatment

The patient had a high risk of rebleeding and the cerebellar supply of PICA was non-dominant, therefore, emergent endovascular patent artery occlusion without bypass surgery was performed putting emphasis on the immediate curability. Under general anesthesia, internal trapping was performed as follows. After a 5 Fr guiding sheath (Shuttle; Cook Medical, Bloomington, IN, US) was placed in the right subclavian artery, systematic heparinization was started to maintain the active clotting time at approximately twice the control value. In coaxial fashion, a 4.2 Fr support catheter (Fubuki; Asahi Intecc, Nagoya, Japan) was introduced into the right V2 portion and the microcatheter (Excelsior SL-10; Kalamazoo, MI, US) was navigated into the lesion. Coils (9 coils, total length 124 cm) were placed tightly only within the dissecting area involving the PICA orifice (Fig. 2B). The final images show the dissecting aneurysm and the PICA were obliterated (Fig. 2C), and the anterior spinal artery was patent.

Postoperative course

On postoperative day 1, the patient come round from general anesthetic (GCS 14), but had hoarseness, dysphagia, and right limb ataxia. Magnetic resonance imaging revealed a new infarction of the right lateral medulla and the right inferomedial cerebellum (Fig. 3A, B). Thereafter, he suffered from aspiration pneumonia and atelectasis, caused by Wallenberg syndrome. On postoperative day 6, peripheral capillary oxygen saturation (SpO_2) rapidly fell into the 60s while sleeping and he was found in a comatose state (GCS 3) with apnea attack (respiratory rate; RR 5/min), which
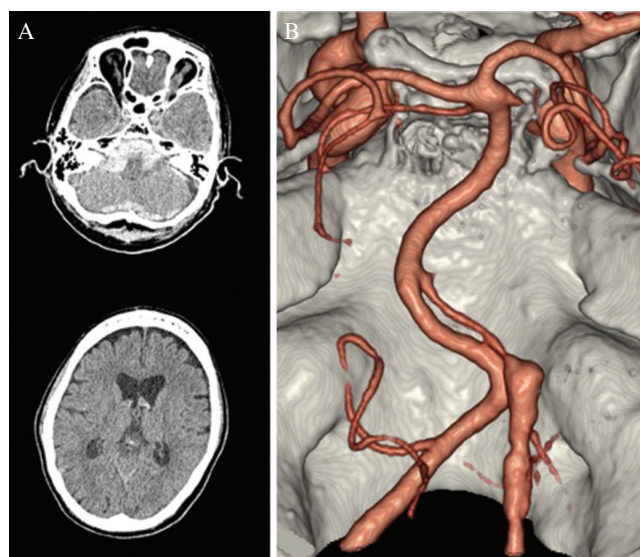
Fig. 1 (A) CT shows thick subarachnoid hemorrhage of the posterior fossa. (B) CT angiography reveals the right vertebral artery dissecting aneurysm involving the posterior inferior cerebellar artery (PICA). An aneurysmal dilatation was detected distal to the PICA bifurcation.
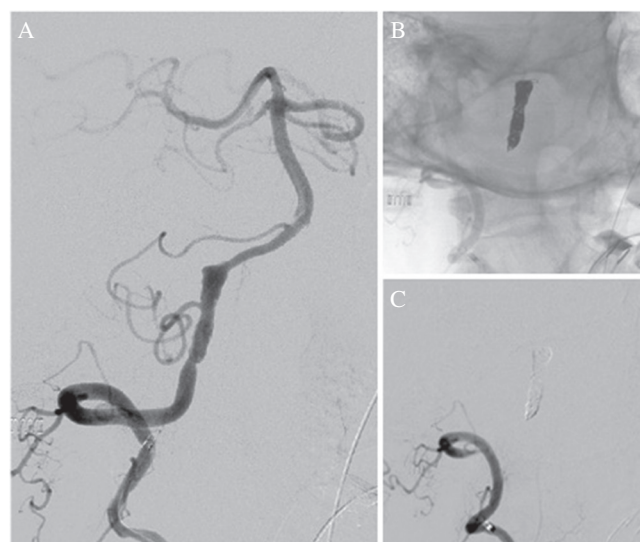

Fig. 2 (A) Oblique view of the right vertebral angiogram shows the right vertebral artery dissecting aneurysm involving the posterior inferior cerebellar artery (PICA). (B) Coils placed within the dissecting area. (C) The dissecting aneurysm and the PICA are obliterated.

Fig. 3 Postoperative magnetic resonance imaging (upper: diffusion-weighted imaging, lower: fluid-attenuated inversion recovery imaging) reveals the right inferomedial cerebellar infarction and lateral medullary infarction (A) extending to the ventral side (B, white arrowhead).

Fig. 4 The vertical axis shows $PaCO_2$ (dark gray) and $ETCO_2$ (light gray). The dotted line and solid line show maximum and minimum respiratory rate respectively. The horizontal axis shows the days from onset. The asterisk means $PaCO_2$ of this point was measured after 10 min forced hyperventilation. White arrows indicate episodes of apnea attack. Black boxes indicate the duration of mechanical ventilation. Black arrowhead indicates the day of tracheostomy.

required oral intubation and mechanical ventilation in order to improve the impairment of gas exchange (Fig. 4). The blood gas analysis (BGA) after 10 min forced hyperventilation showed mild hypercapnia ($PaCO_2$ 52.4 mm Hg). Mechanical ventilation improved the hypercapnia, hypoxia, and conscious disturbance within a few hours (GCS 13), although incomplete cough and gag reflex and occasional hypoventilation remained. CT angiography, contrast enhanced chest CT, echocardiogram, bronchoscope and bedside electroencephalogram on the same day revealed no apparent causative lesion. On postoperative day 9, a tracheostomy 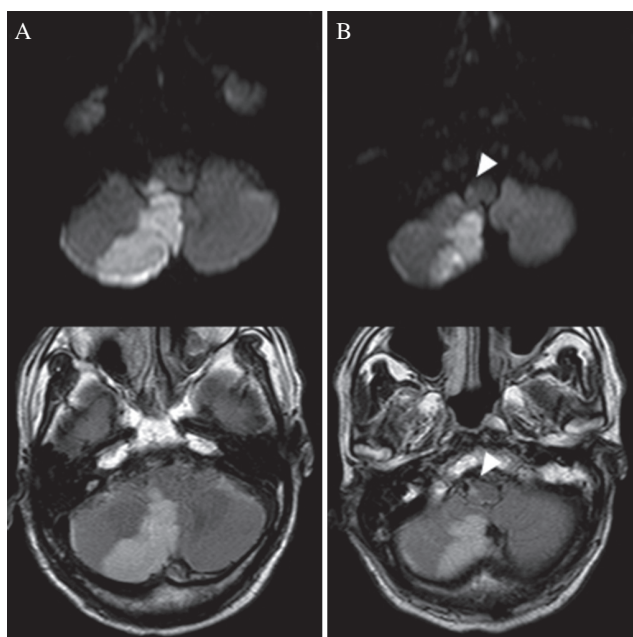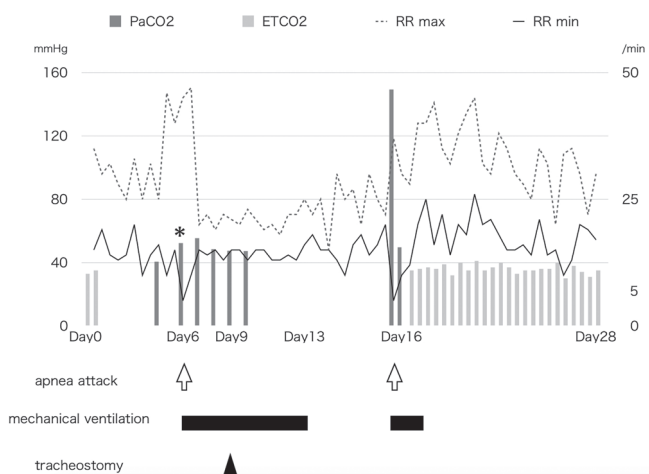was performed and on day 13, he was weaned from intermittent mechanical ventilation. On postoperative day 16 the apnea (RR 4/min, pause >10 sec) and conscious disturbance (GCS 4) recurred with hypoxia (SpO_2 85%) while sleeping. The BGA showed remarkable hypercapnia ($PaCO_2$ 149.3 mm Hg) without remarkable abnormality on chest X-ray (Figs. 4, 5). And this acute deterioration was recognized to result from CO_2 narcosis following central hypoventilation Mechanical ventilation was restarted, which improved gas exchange and the conscious disturbance (GCS 14) after 30 min, and he was
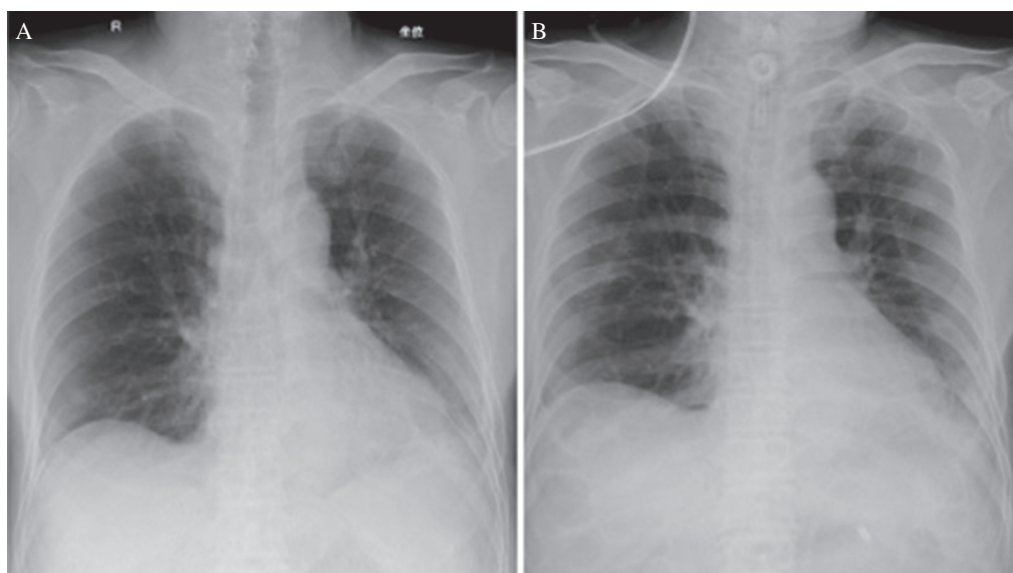
Fig. 5 Chest X-ray of postoperative day 0 (A) and day 16 (B) revealed no severe pneumonia and atelectasis.

successfully weaned from the respirator a few days later. Respiratory rehabilitation was also started under end tidal CO_2 ($ETCO_2$) monitoring, and no additional apnea attacks occurred. Pharyngeal hyporeflexia and severe dysphagia persisted, hence a gastrostomy was performed and a tracheostomy was maintained. On postoperative day 53 he was transferred to a rehabilitation hospital with a tracheostomy (mRS score 4).

Discussion

The rebleeding rate of hemorrhagic VADs is very high (30–70%) during the acute phase,[1–4] therefore prompt treatment is required. Surgical and endovascular treatment is feasible for VADs involving PICA to avoid rebleeding, however any treatment modality has the possibility of medullary perforators flow disturbance, which arise from the VAD, especially less than 14 mm proximal to the VA union.[5]

In our case, postoperative images revealed the right lateral medullary infarction extending to the ventral side and the right cerebellar infarction, the former infarction leading to more critical complications involving Wallenberg syndrome and severe respiratory disorders. On postoperative day 6 rapidly progressive conscious disturbance and apnea occurred, and the patient required intubation and mechanical ventilation. Several detailed examinations revealed that cerebral vasospasm, neurogenic stress cardiomyopathy, arrhythmia, airway obstruction, pulmonary embolism, and epilepsy were absent; meanwhile, mild hypercapnia after induced forced hyperventilation was unexplained. On postoperative day 16 when the conscious disturbance recurred, frequent apnea (>10 sec) and remarkable hypercapnia supported a diagnosis of CO_2 narcosis caused by CHS secondary to the lateral medullary infarction. All five angiography studies between postoperative day 2 and 16, including CT angiography, magnetic resonance angiography and DSA revealed no angiographical vasospasm of major vessels, which might have caused further ischemic event.

Respiratory centers are composed of three groups of neurons spreading in the bilateral brain stem as follows: (a)

the dorsal respiratory group (DRG), which consist of inspiratory neurons, is located ventrolateral to the solitary nuclei of the medulla; (b) the ventral respiratory group (VRG), which consists of inspiratory, expiratory and rhythm-generating neurons, is a long column of neurons extending from the cervical cord C1 to just below the facial nuclei; and (c) the parabrachial/Kölliker-Fuse complex, which controls switching between inspiration and expiration, is located dorsolateral of the upper pons.[6,7] Central respiratory center disorders may induce various kinds of central hypoventilation. VRG impairment, such as in our case, can cause central apnea and loss of automatic respiratory control.[7] Autonomic respiration, which is important while sleep, is controlled by feedback mechanisms dependent on changes in oxygen, carbon dioxide, and pH in the blood and CSF. Only around 20 cases of CHS secondary to unilateral medullary infarction have been reported,[8] and ours is the first case induced by endovascular treatment, to the best of our knowledge.

As a surgical treatment strategy for hemorrhagic VADs involving PICA, trapping of the whole dissecting area with an occipital artery-PICA bypass is recommended in order to obtain high curability and reduce ischemic complications. Endovascular internal trapping of dissecting areas with or without bypass surgery is also feasible. In cases contraindicated to internal trapping, stent-assisted coil embolization (SAC) may be an alternative,[9,10] but the possibility of VAD recurrence or perforating artery ischemia after SAC remains.[11] Chung et al. reported feasibility of proximal VA to PICA stent placement and coil embolization of residual dissecting VA for VAD involving PICA,[12] This preservation of unidirectional VA to PICA flow to reduce cerebellar ischemia. However, it is to be noted that both vessel reconstruction and patent artery preservation can cause medullary infarction which exacerbates the long-term functional prognosis[13] and rarely leads to CHS.

Our patient twice experienced rapidly progressive conscious disturbance that occurred while sleeping in the

intensive care unit. Immediate respiratory care, which includes intubation, tracheostomy, ETCO$_2$ monitoring, and supportive mechanical ventilation, enabled him to recover to a pre-attack condition. CHS secondary to lateral medullary infarction is prone to emerge reversibly in the acute and subacute phase, and can be lethal without adequate treatment.[7] Moreover, in cases complicated with early brain injury or delayed cerebral ischemia after SAH, CHS patients may present with various neurological symptoms that confuse the definitive diagnosis. Therefore, such patients should be managed under intensive respiratory monitoring during the acute and subacute phases.

Conclusion

A patient with hemorrhagic VAD involving PICA presented with CHS secondary to a lateral medullary infarction after endovascular patent artery occlusion of the dissecting vessel. CHS patients with SAH require intensive monitoring of their respiratory state, and immediate diagnosis and treatment improves their prognosis.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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