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Research Article

Nonsurgical treatment of obstructive hydrocephalus by face-down positioning: Report of four cases

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ABSTRACT

Background: Transient obstructive hydrocephalus is a rare condition. Previous case reports have described spontaneous resolution of obstructive hydrocephalus, although the entire mechanism has not yet been clarified.
Case description: We report four cases of transient obstructive hydrocephalus after subarachnoid hemorrhage (2 cases) and intra-cerebral hemorrhage (2 cases) caused by obstruction of the aqueduct in patients who presented with altered consciousness that resolved soon after changing their posture from the supine to semi-prone (face-down) position.
Conclusions: Face-down positioning might be beneficial for patients with delayed obstructive hydrocephalus, especially that due to a mobile hematoma in the third ventricle.

1. Introduction

Patients with intra-ventricular hematoma (IVH) sometimes develop obstructive hydrocephalus, which has the potential to cause severe mortality and disability [1,2]. Although cerebrospinal fluid (CSF) drainage should be considered emergently in such a situation, several previous case reports have described spontaneous resolution of obstructive hydrocephalus [3–7]. In almost every case, the clot that had moved to the entrance of the cerebral aqueduct was suspected to disturb normal CSF flow, with subsequent exacerbation of hydrocephalus. In these reports, in the patients who developed delayed hydrocephalus after intracranial hemorrhage or subarachnoid hemorrhage (SAH) with a small amount of IVH, changing their posture from the supine to face-down (semi-prone) position was performed, in anticipation that the obstructing hematoma would move away from the entrance of the cerebral aqueduct (Fig. 1). We report an experimental single-cases study of four consecutive cases of delayed development of hydrocephalus treated at our institute from August 2016 to August 2019 that showed resolution of hydrocephalus soon after the procedure.

2. Case Presentation

Case 1: A 55-year-old female was admitted to our hospital with sudden onset of severe headache. On admission, she was completely conscious and had no other remarkable symptoms. A non-contrast head computed tomography (CT) was ordered, which was significant for diffuse subarachnoid hemorrhage (SAH) partially extending into the anterior part of the third ventricle and without enlargement of the ventricles (Fig. 2A). Three-dimensional (3D) CT angiography demonstrated multiple aneurysms in the anterior communicating artery and left internal carotid paraclinoid region. We planned to treat these aneurysms by endovascular coil embolization the next day. Within about 6 h after admission, her consciousness abruptly deteriorated to a state of semi-coma. (Glasgow coma scale (GCS): E1V1M5) Her pupils' size and response to light was normal. Urgent CT showed development of hydrocephalus, suggesting that a previously existing hematoma in the anterior part of the third ventricle had migrated to the entrance of the cerebral aqueduct (Fig. 2B). CT scan did not suggest an increase in the amount of intracranial hematoma, and there were no other signs indicative of re-rupture of the aneurysm. Under strict observation in the stroke care unit, the patient's posture was changed from the supine to semi-prone position after getting the family's consent, in anticipation that the thrombus would move out of the cerebral aqueduct. Her consciousness recovered within 1 h, and follow-up CT scan performed 26 h after the first CT on admission showed a decrease in ventricular size (Fig. 2C). The patient underwent endovascular surgery for her aneurysms on the second day of hospitalization, as previously scheduled (Fig. 2D). Her postoperative course was favorable and she was discharged without any sequelae to the transient hydrocephalus.

Abbreviations: CPP, cerebral perfusion pressure; CSF, cerebrospinal fluid; CT, computed tomography; GCS, glasgow coma scale; ICP, intra-cranial pressure; IVH, intra-ventricular hematoma; MRI, magnetic resonance imaging; SAH, subarachnoid hemorrhage

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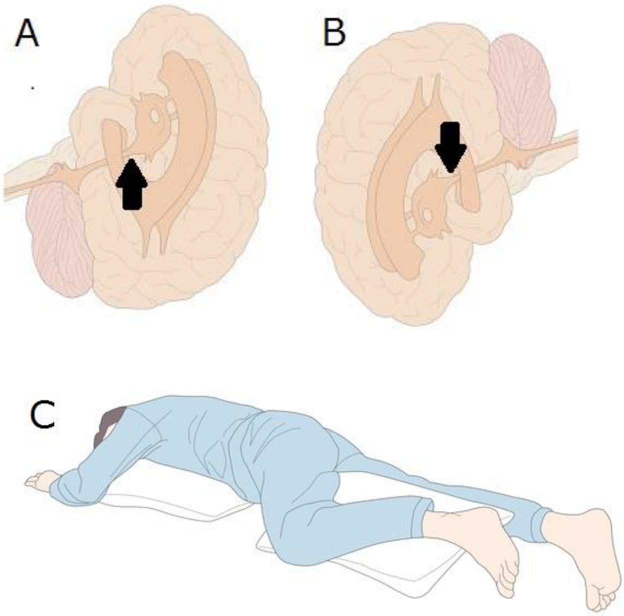

Fig. 1. Images of the cerebral ventricles in the supine (A) and semi-prone (B) positions, revealing how the entrance to the aqueduct, which is the lowest part of the third ventricle in the supine position (black arrow), becomes highest in the prone or semi-prone position (black arrow). (C) Face-down (semi-prone) position. (Copyright © PIXTA).

Case 2: A 53-year-old male was admitted to our hospital under the suspicion of acute stroke due to sudden onset of dysarthria and right mild hemiparesis. His past medical history was significant for hypertension and alcohol abuse. Head magnetic resonance imaging (MRI) on admission demonstrated left thalamic hemorrhage with hematoma invasion of the third and lateral ventricles, but without hydrocephalus (Fig. 3A). The patient received conservative treatment under strict blood pressure control to a normotensive level (< 140 mmHg) in the stroke care unit. Follow-up CT performed 3 h after admission showed no change from the previous MRI (Fig. 3B). Thirteen hours later, his level of consciousness deteriorated from mild disorientation to somnolence (GCS: E3V4M6). Emergency CT at this time revealed enlargement of the lateral ventricles, suggesting blocking of the third ventricle by the hematoma, causing obstructive hydrocephalus (Fig. 3C). In an attempt to relieve the obstruction, we changed the patient's posture from the supine to semi-prone position after obtaining the family's consent, while being prepared to perform a CSF drainage procedure if required. Thereafter, his consciousness gradually recovered and CT performed 6 h after the ictus showed improvement of the hydrocephalus (Fig. 3D). He was kept in this position for 5 days, until follow-up CT confirmed that the hematoma was absorbed and there was no recurrence of hydrocephalus (Fig. 3E). He was subsequently transferred to a rehabilitation hospital to receive further treatment for his residual cognitive dysfunction.

Case 3: A 79-year-old male who presented with acute onset of left hemiparesis was admitted to our hospital, where he was diagnosed with right thalamic hemorrhage with hematoma extending into the third and lateral ventricles. There was no evidence of hydrocephalus on the first CT (Fig. 4A). As per convention, the patient received conservative

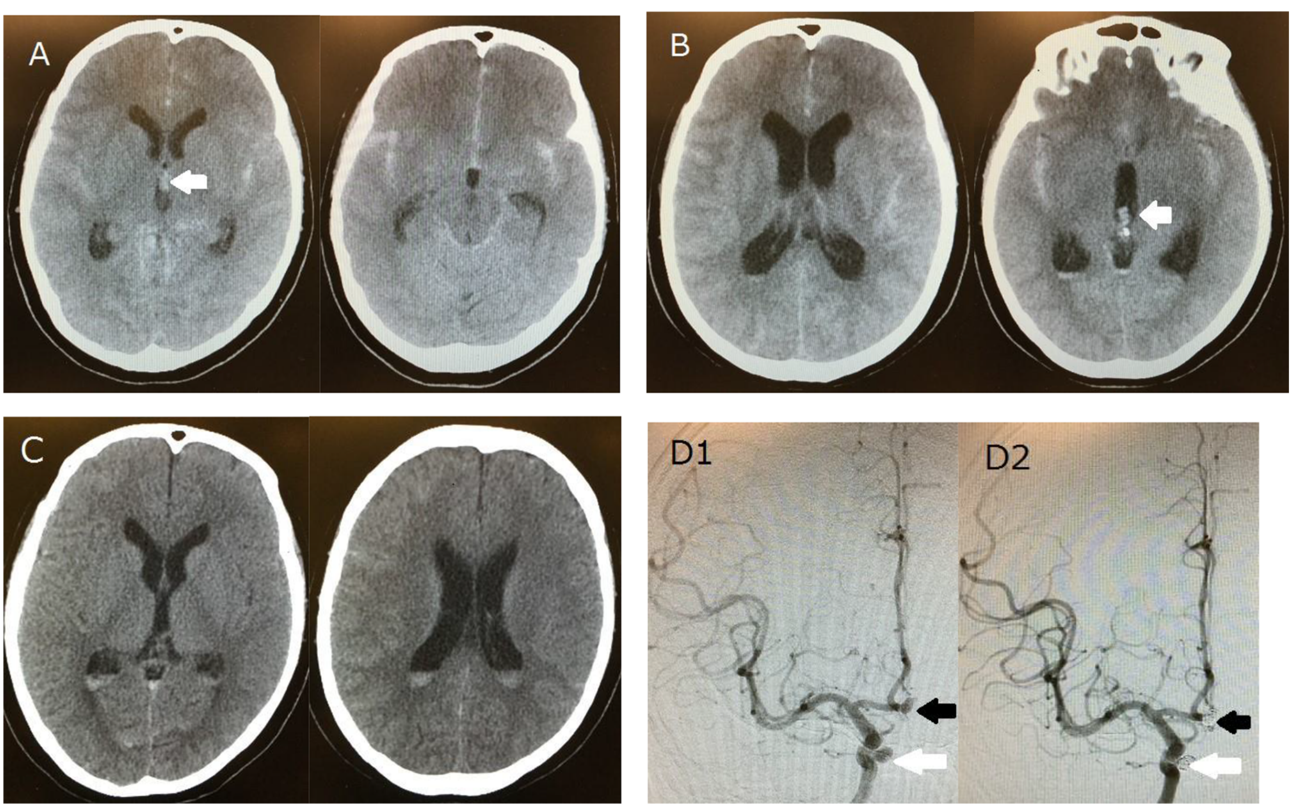

Fig. 2. (A) Axial head CT scans on admission in case 1 showed diffuse SAH and intraventricular hematoma in the third ventricle (white arrow), without evidence of ventriculomegaly. (B) Axial CT scan obtained 6 h after presentation in case 1 demonstrated the delayed development of hydrocephalus, suggesting that the previously existing hematoma in the third ventricle had migrated to the entrance of the aqueduct (white arrow). (C) CT obtained about 20 h after the development of hydrocephalus in case 1 revealed resolution of the hydrocephalus and disappearance of the clot in the third ventricle. (D1) A right internal carotid angiogram performed on admission in case 1 revealing an anterior communicating artery aneurysm (black arrow) and paraclinoid aneurysm (white arrow). (D2) Postoperative angiogram demonstrated complete obliteration of the aneurysms (arrows).

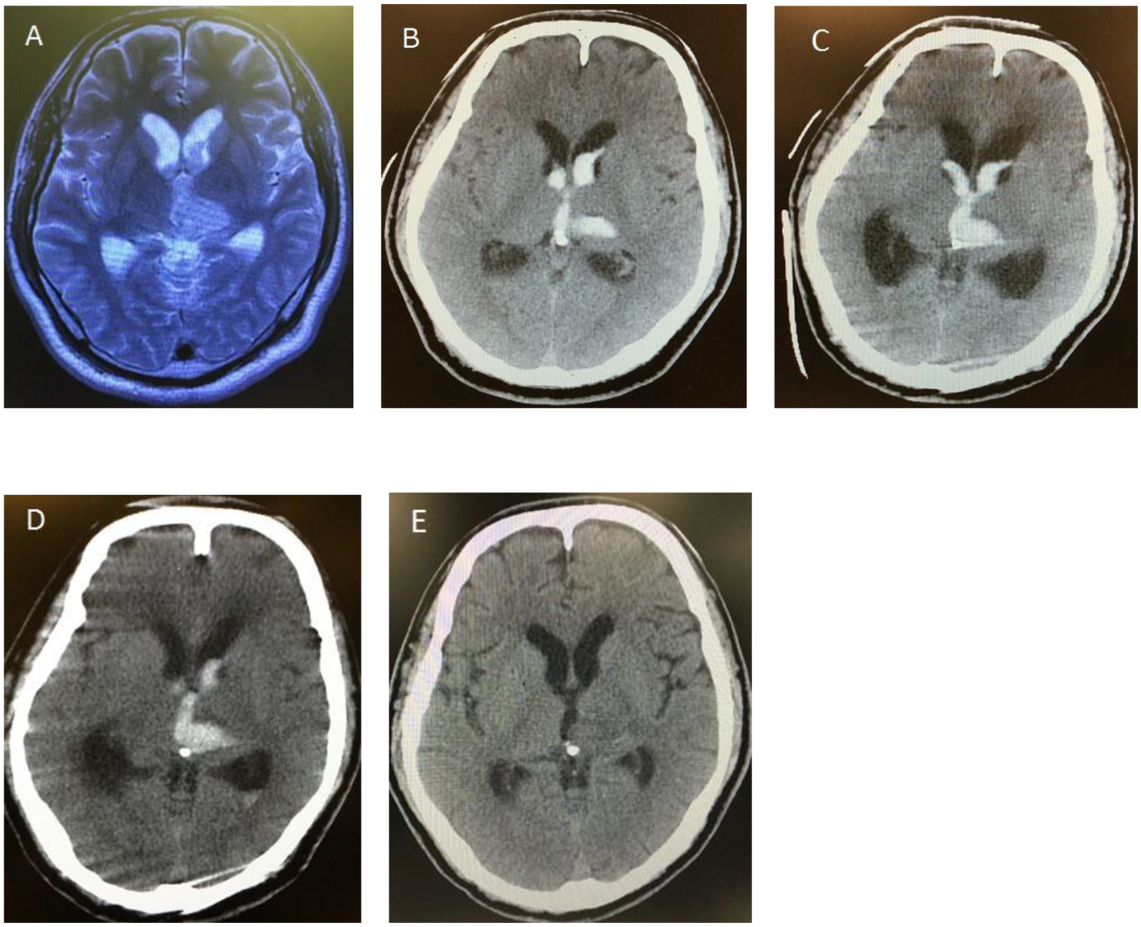

Fig. 3. (A) An axial T2-weighted MRI performed at admission in case 2 showed left thalamic hemorrhage with extension into the third and lateral ventricles. (B) Axial CT performed 3 h after admission showed no evidence of ventriculomegaly. (C) Axial CT performed approximately 16 h after admission in case 2 showed significant increase in size of the lateral ventricle. (D) Axial CT 6 h after the ictus in case 2 showed improvement of hydrocephalus. (E) CT performed five days confirmed gradual absorption of the hematoma, with no recurrence of hydrocephalus.

treatment under strict blood pressure control in the stroke care unit. Follow-up CT scan 14 h after admission showed no remarkable changes, although his level of consciousness deteriorated into a comatose state (GCS: E1V2M5) with normal pupil size and response to light about 34 h after admission. An urgent CT scan revealed hydrocephalus that was obviously due to obstruction by the hematoma at the bottom of the third ventricle (Fig. 4B). Changing the patient's posture from the supine to semi-prone position was performed after having the consent from the patient's family in an attempt to dislodge the hematoma from the aqueduct. Soon thereafter, his level of consciousness began to improve and resolved within 2 h. The semi-prone position was maintained for 3 days. Follow-up CT performed 7 days after the onset of hydrocephalus showed that the blood clot in the third ventricle had disappeared completely (Fig. 4C).

Case 4: The patient was an 87-year-old female who was diagnosed with SAH of unknown etiology. Her past medical history included SAH due to rupture of the tip of a basilar aneurysm, that was treated by endovascular surgery the previous year. At the initial assessment, the patient was awake but disorientated, but with no neurological deficits. A CT scan at admission demonstrated IVH within the frontal horn and third ventricle bilaterally, but with no dilatation of the ventricles (Fig. 5A). Repeat CT at an interval of several days demonstrated no remarkable change in the ventricles (Fig. 5B). On the fifth day, she suddenly presented with a decreased level of consciousness (GCS: E1V1M5) Her pupils' size and response to light was normal. An urgent plain MRI revealed enlargement of the lateral and third ventricles, along with evidence of blockage of the cerebral aqueduct due to hematoma, which was thought to have induced obstructive hydrocephalus (Fig. 5C). In order to relieve the obstruction, the patient's posture was changed from the supine to semi-prone position after having the family's consent for the treatment while preparing for CSF drainage (Fig. 5D). Soon after the change in posture, her consciousness recovered to such an extent that spontaneous limb movement was seen. Follow-up CT scan performed 3 h later showed that the blood clot in the floor of the third ventricle had moved to the left foramen of Monro, and there was slight shrinkage of the lateral ventricles (Fig. 5E). Hence, the patient was kept under observation without CSF drainage. As the next CT scan performed 3 h later once again demonstrated the presence of a blood clot on the floor of the third ventricle (Fig. 5F), the semi-prone position was maintained until the following day. Subsequently, the patient showed progressive clinical improvement and recovered fully. CT scan showed that the clot in the third ventricle had disappeared and the size of the ventricles was within the normal range (Fig. 5G).

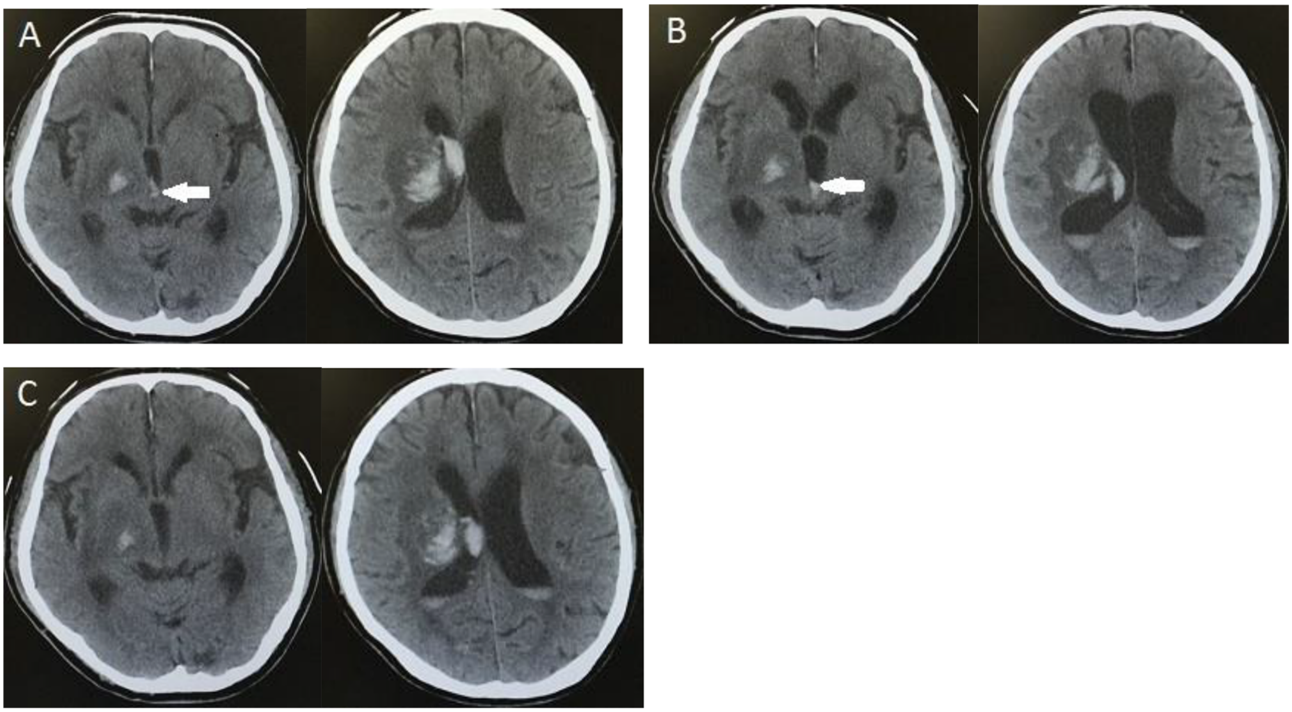

Fig. 4. (A) CT scan in case 3 showing right thalamic hemorrhage with hematoma extending into the third and lateral ventricles (white arrow). Hydrocephalus was not seen in the first CT. (B) An urgent CT scan performed about 34 h from symptom onset in case 3 revealed hydrocephalus that was obviously due to obstruction by the hematoma in the lower part of the third ventricle (white arrow). (C) Follow up CT performed 7 days later showed that the blood clot in the third ventricle had disappeared completely and hydrocephalus had resolved.

3. Discussion

Obstructive hydrocephalus is a well-documented complication of intracranial hemorrhage, including intracerebral hematoma and subarachnoid hemorrhage [8]. CSF drainage is the common procedure of choice for the emergency treatment of acute hydrocephalus, despite the risk of infection and the other associated complications [9–10]. Particularly in patients with ruptured aneurysms, rapid lowering of intracranial pressure (ICP) by CSF drainage might induce of the aneurysm rupture [11]. The serial images of our cases visually demonstrate the various possible mechanisms of delayed obstructive hydrocephalus. First, as three of our cases (cases 1, 3 and 4) and other reported cases demonstrated, a tiny hematoma might migrate from another site to the bottom of the third ventricle, plugging the aqueduct [3–5]. Second, as suggested by our second case, since the hematoma occupied almost the entire third ventricle, although CSF initially managed to make its way through the aqueduct, subsequent plugging of the aqueduct led to the development of hydrocephalus. It is obvious that if the patients were positioned in the face-up position, the clots, which are heavier than CSF, would be likely to sink to the bottom of the third ventricle, causing obstruction of the aqueduct.

Acute stroke patients are often routinely positioned with their face up. Moreover, treatment with antifibrinolytic drugs, such as tranexamic acid, which is commonly used for stroke patients, might accelerate stabilization of the hematoma, increasing the possibility of CSF flow interruption [12–13]. In particular, as seen in case 4, keeping the head face-down inverts the relative positions of the ventricles and the aqueduct, preventing the clot from being fixed onto the posterior part of the third ventricle under the influence of gravity. Of course, this requires continuous, strict observation and frequent monitoring of vital signs in the stroke care unit. While spontaneous recovery of obstructive hydrocephalus has also been previously reported [3–7], our cases are the only ones highlighting the importance of patient position. In the face-up position as well, while it is possible that the migrated hematoma might have a chance to move away from the aqueduct because CSF passage through the narrow aqueduct is pulsatile in nature, with a systolic and diastolic to-and-fro displacement [14], or ongoing fibrinolytic activity in the CSF might allow decomposed clot fragments to pass through the aqueduct in combination with increased intracranial pressure due to hydrocephalus [15], a change in position can also promptly and efficiently relieve the blockage. However, it should be pointed out that in patients with acute hydrocephalus due to a considerable amount of hematoma in the ventricles, or those in whom the CSF pathway is already collapsed by massive intraparenchymal hematoma, CSF drainage or endoscopic surgery should be performed without delay, because the hematoma might not adequately shift or resolve in such situations, even if changing the patient's position is attempted immediately.

Treatment of patients in the prone or semi-prone position is a common method to improve oxygenation in general intensive care units. Although the procedure was safely carried out in this report, some reports have pointed out that the prone position results in raised ICP, even though it improves oxygenation as well as cerebral perfusion pressure (CPP) [16]. As it is still unverified whether the benefits of improving the level of oxygenation and CPP outweigh elevation of ICP, the prone or semi-prone position should be used cautiously in patients with reduced intracranial compliance [17]. Based on this preliminary success, further prospective controlled studies are warranted and indicated to study the efficacy and the safety of the procedure.

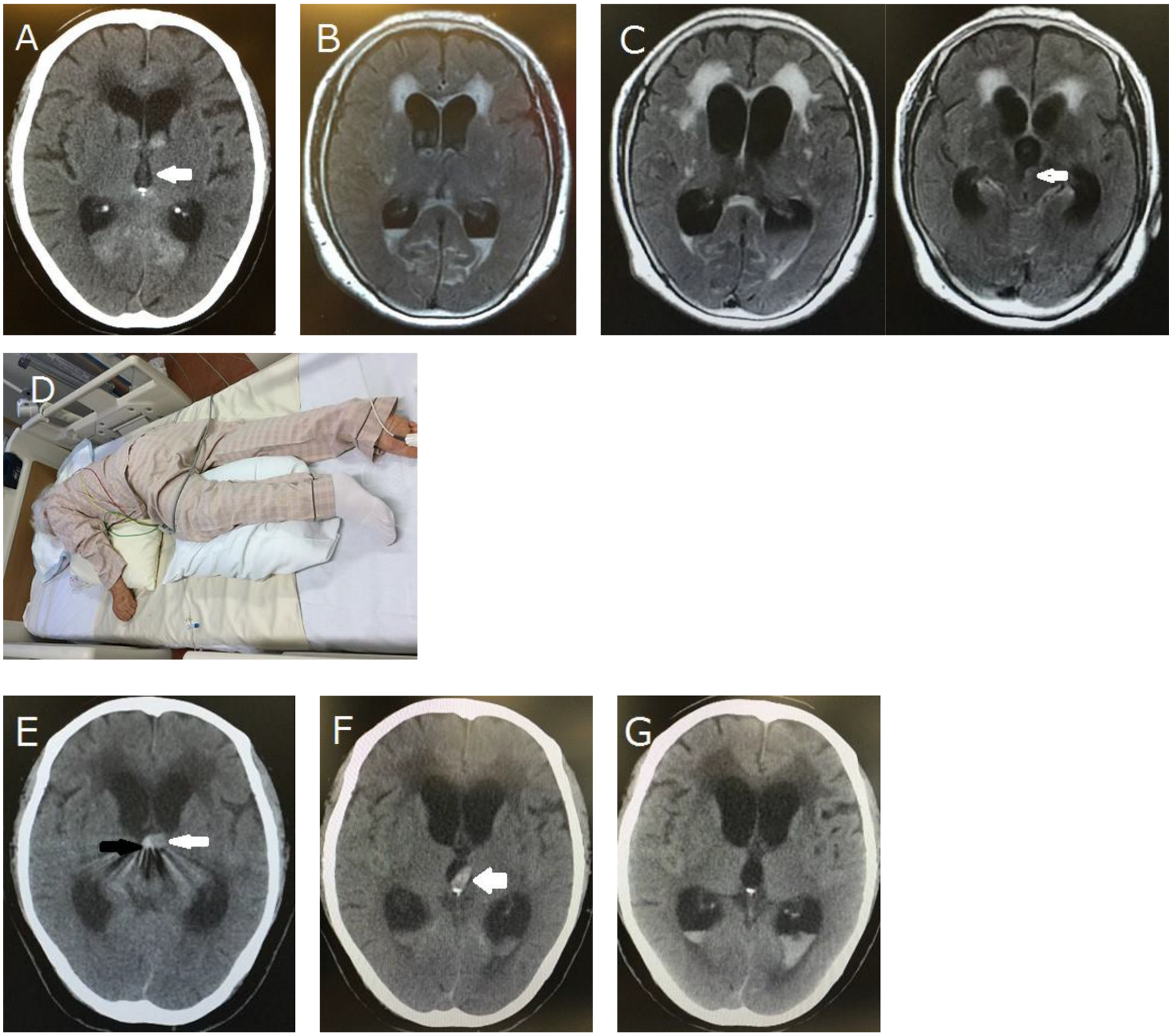

Fig. 5. (A) Axial CT at admission in case 4 demonstrated SAH and IVH within bilateral frontal horns and the third ventricle. (B) Axial MRI (FLAIR) three days after admission showed no delayed changes in the ventricles. (C) Plain axial MRI in case 4 revealed enlargement of the lateral and third ventricles, along with blockage of the cerebral aqueduct by hematoma (white arrow), which was suspected to have induced obstructive hydrocephalus. (D) Pictures of the patient after changing to the semi-prone face down position. (E) CT scan performed 6 h after manifestation of hydrocephalus in case 4 showed that the clot (white arrow), adjacent to a coil mass (black arrow), in the third ventricle was shifted to near the left foramen of Monro, along with decrease in the size of the ventricles. (F) CT scan performed 3 h later demonstrated the presence of the blood clot (white arrow) on the floor of the third ventricle. (G) CT scan on the following day showed disappearance of the clot in the third ventricle.

4. Conclusions

Under sufficient understanding of the pathophysiological mechanisms of hydrocephalus, patients with delayed obstructive hydrocephalus due to hematoma in the third ventricle might benefit from being placed in the face-down position to promote clot movement away from the aqueduct.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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