A Case of Stent Placement for Intracranial Hypertension Associated with Venous Sinus Stenosis

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Objective: We encountered a patient with chronic headache due to intracranial hypertension associated with venous sinus stenosis. The symptom was alleviated after stent placement at the site of stenosis.

Case Presentation: The patient was a 33-year-old man with chronic headache as a chief complaint. MRI revealed stenosis of the right transverse and occipital sinuses. Intracranial hypertension was diagnosed by a lumbar puncture. Although lumboperitoneal shunting was performed after conservative treatment, no symptomatic improvement was observed. The venous pressure was measured at the time of cerebral angiography. Since intracranial hypertension and a transstenotic venous pressure gradient were observed, stent placement was performed, resulting in alleviation of headache.

Discussion: Transverse sinus stenosis can be a cause of intracranial hypertension although rarely. Stent placement is considered to be a treatment worth attempting in patients who resist medical treatments or cerebrospinal fluid shunting.

Keywords ▶ transverse sinus stenosis, intracranial hypertension, sinus stenting

Introduction

Benign intracranial hypertension is known to be a causative disorder of chronic headache. Although it is most frequently caused by obesity, its cause is often unidentified.¹⁾ We encountered a patient with chronic headache due to intracranial hypertension associated with multiple venous sinus stenoses. Measurement of the venous pressure demonstrated intracranial hypertension and a transstenotic pressure gradient. The symptom was alleviated by stent placement at the site of stenosis.

Case Presentation

The patient was a 33-year-old male with a history of atopic dermatitis. There was no drug allergy. The patient was

referred to our hospital with chronic headache as a chief complaint. Splitting, sustained, and intense pain of the entire head was accompanied by nausea, vomiting, and anorexia. The symptom showed no change with shift of the body position. Magnetic resonance (MR) venography showed stenoses in the right transverse and right occipital sinuses (**Fig. 1A**). On MRI, no ventricular enlargement was noted, and hydrocephalus was considered unlikely (**Fig. 1B**). No finding suggestive of cerebrospinal fluid (CSF) hypovolemia, such as dural enhancement, was observed. Measurement of the CSF pressure by lumbar puncture showed intracranial hypertension at 23–25 cmH₂O, and CSF drainage resulted in alleviation of headache for about 24 hours. Since sustained control of the symptom could not be achieved by conservative treatment, lumboperitoneal shunting (LPS) was performed 1 month after the first examination. Although headache was alleviated after the procedure, abdominal and perineal pain appeared. Since radicular symptoms were suspected, the catheter placed in the spinal canal was withdrawn over about 2 cm and re-fixed, but no symptomatic improvement was observed. Therefore, allergy to catheter materials was considered as a possibility. No response to analgesics or anti-allergic drugs was observed, and the shunt was removed 2 months after its placement. Although abdominal and perineal pain disappeared after shunt removal, headache recurred. Since the cause of the abdominal

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Fig. 1 (A) MR venography. Flow gaps were observed in the right transverse and occipital sinuses, indicating severe stenosis. (B) T2-weighted image. No ventricular dilation was noted. MR: magnetic resonance

and perineal pain after shunt placement was unclear, ventriculoperitoneal shunting (VPS) was not considered more effective than LPS. The right visual acuity declined to 0.7 after 1 month of shunt removal. Funduscopy revealed bilateral papilledema, and a diagnosis of visual dysfunction due to intracranial hypertension was made. Cerebral angiography was performed to measure the venous pressure.

Cerebral angiography

The procedure was performed under local anesthesia. Beads-like severe stenoses were noted in the right transverse sinus (**Fig. 2**). The right sigmoid sinus was perfused earlier from the left vein of Labbé than from the superior sagittal sinus (SSS), and delayed outflow from the SSS to the right transverse and occipital sinuses was observed. Stenoses were also detected in the right occipital sinus. The outflow to the left transverse sinus was primarily from the sinus rectus, and the communication of the confluence of sinuses was unclear. Similar findings were also obtained by left internal carotid arteriography. Using a 5 Fr Envoy (Johnson & Johnson, Tokyo, Japan) as a guide, Prowler Select Plus (Johnson & Johnson) was advanced to the latter half of the SSS via the narrowed right transverse sinus. The systolic venous pressure was 30 cmH₂O in the latter half of the SSS, 32.6 cmH₂O in the distal part of the transverse sinus, 20.4 cmH₂O in the proximal part of the transverse sinus, and 15 cmH₂O in the internal jugular vein (IJV), and the transstenotic pressure gradient was 15 cmH₂O (**Table 1**). Since intracranial hypertension and a transstenotic venous pressure gradient were demonstrated, stent

placement was designed to relieve stenoses of the transverse sinus. The unapproved use of a carotid artery stent was permitted by the Institutional Review Board.

Endovascular surgery

Dual-antiplatelet therapy (DAPT) consisting of aspirin and clopidogrel was initiated 1 week before the procedure. Under general anesthesia, sheaths were placed in the artery and vein via the bilateral femoral regions. On the arterial side, the sheath was placed in the right internal carotid artery for control arteriography. An 8 Fr Brite Tip (Johnson & Johnson) was placed in the right IJV. Pre-dilation was performed using a 3.0 mm × 40 mm SLEEK (Johnson & Johnson). The balloon was inflated but completely recoiled to the original state. Satisfactory dilation could be achieved by directly advancing an 8 mm × 30 mm Precise (Johnson & Johnson) and deploying it at the site of stenosis (**Fig. 3**). The pressure gradients measured in this state were 13.6 cmH₂O in the latter half of the SSS, 12.2 cmH₂O in the distal part of the transverse sinus, 12.2 cmH₂O in the proximal part of the transverse sinus, and 10.9 cmH₂O in the IJV, and the transstenotic pressure gradient decreased to 2.7 cmH₂O (**Table 1**). The perfusion velocities of the SSS and right vein of Labbé became nearly equal.

Postoperative course: No perioperative complication was observed. One week after the procedure, headache was alleviated to about half the preoperative level. Headache newly appeared in the frontal region, but it was resolved spontaneously. Papilledema disappeared 1 month after surgery. Since satisfactory stent patency could be confirmed by cerebral angiography 3 months after surgery, DAPT

Fig. 2 Towne views of early (A) and late (B) venous phase right internal carotid arteriography and frontal view of left internal carotid arteriography (C). The outflow from the SSS to the right transverse and occipital sinuses was delayed compared with that from the right vein of Labbé. The outflow to the left transverse sinus was primarily from the sinus rectus, and the communication of the confluence of sinuses was unclear. Lateral volume rendering image (D). Marked stenosis was observed in the right transverse and occipital sinuses. SSS: superior sagittal sinus

Table 1 Results of venous pressure measurement before and after stent placement

	Preoperative (cmH ₂ O)	Postoperative (cmH ₂ O)
Latter one-third of the SSS	30	13.6
Confluence of sinuses	30	12.2
Distal transverse sinus	32.6	12.2
Narrowest portion	32.6	12.2
Proximal transverse sinus	20.4	12.2
Transverse-sigmoid sinus transition	16.3	12.2
Sigmoid sinus	15	10.9
Jugular bulb	15	–
Internal jugular vein	15	10.9
Pressure gradient	15	2.7

The maximum venous pressure and pressure gradient before surgery were 32.6 and 15 cmH₂O respectively, but those after surgery were improved to 12.2 and 2.7 cmH₂O, respectively. SSS: superior sagittal sinus

was changed to single antiplatelet therapy (SAPT) using clopidogrel alone. Measurement of the CSF pressure by lumbar puncture also showed a decrease to 17 cmH₂O. Thereafter, stent patency was checked by periodic contrast-enhanced CT. Headache disappeared 1 year after surgery.

Discussion

A group of diseases associated with intracranial hypertension with unknown causes is defined as idiopathic intracranial hypertension. It often affects young obese women.

Fig. 3 (A) Precise was placed in the transverse sinus. In the frontal (B) and lateral (C) views of cerebral angiography, stenosis of the transverse sinus was relieved, and satisfactory dilation was achieved.

The symptoms are diverse and include headache, visual impairment, cranial nerve disorders, pulsatile tinnitus, and neck and back pain. Previous imaging examinations showed no organic abnormalities, and an increase in the central venous pressure related to increased cerebral blood flow, impairment of the venous outflow tract, and obesity has been suggested as a possible cause. In obese patients, guidance for weight control is often indicated as a treatment.^{1,2)} If no symptomatic improvement is observed, CSF shunting may be considered as a treatment.³⁾ Intracranial hypertension may be caused by organic disorders such as stenosis of the venous sinus. Other than tumoral and angiopathic lesions, large arachnoid granules, ectopic fat, and small cerebral hernia toward the venous side have been reported as conditions that may cause venous sinus stenosis.⁴⁾ In patients with intracranial hypertension caused by disturbance of the venous return, only stenosis of the venous sinus is observed by imaging examinations, and as no ventricular enlargement or stenosing disorders are delineated, understanding of the pathology is extremely difficult. In the patient reported here, the communication of the confluence of the left and right venous sinuses was unclear, and stenosis was noted in both the right transverse and occipital sinuses, which are the outflow tracts from the SSS, and intracranial hypertension is considered to have been caused by impairment of the outflow tracts. Clinical alleviation of the symptoms could be achieved by relieving the stenosis of the venous sinuses by stent placement. Since our patient resisted conservative treatment, we performed LPS, but the stent was removed due to the occurrence of abdominal and perineal pain after LPS. The position of the catheter in the spinal canal was changed, but no symptomatic improvement was observed.

Since the patient had an atopic constitution, allergy rather than radicular symptoms was suspected. Silicone allergy has been reported as a cause of unsuccessful VPS.⁵⁾ Since abdominal and perineal pain after LPS did not respond to oral analgesics or anti-allergic drugs, another treatment had to be selected.

King et al.⁶⁾ first reported stenosis of the transverse sinus and a transstenotic pressure gradient in patients with intracranial hypertension. Higgins et al.⁷⁾ first performed stent placement for intracranial hypertension due to transverse sinus stenosis. According to a review of 207 surgical cases of 19 reports by Teleb et al., headache and papilledema were alleviated postoperatively in 81% and 90% of the patients, respectively. The mean venous sinus pressure distal to the area of stenosis decreased from 30.3 mmHg before surgery to 15 mmHg after surgery, and the mean venous sinus pressure gradient decreased from 18.5 mmHg before surgery to 3.2 mmHg after surgery. As serious complications, three cases of subarachnoid hematoma, vascular perforation, and retroperitoneal bleeding were reported.²⁾ The stent patency rate during a 4-year follow-up period was reportedly 98.7%.²⁾ Recurrence of venous sinus stenosis was observed outside the stent.⁸⁾ There have been reports of VPS performed in cases with clinical symptoms recurring despite patent stents.²⁾ They proposed the items shown in **Table 2** as criteria for stent placement for intracranial hypertension due to transverse sinus stenosis.²⁾ Our patient fulfilled all their major criteria and minor criteria regarding severe transverse sinus stenosis on MRI and unsuccessful LPS.

Concerning the stents that are actually used, there have been many reports of the use of carotid artery stents such

Table 2 Diagnostic criteria proposed in the report by Telab et al.²⁾**Major criteria (all required for qualification)**

Failed maximal medical therapy or fulminant course refractory to medical treatment with rapidly worsening vision
 Presence of pressure gradient across the stenosis ≥ 8 mmHg
 Pressure ≥ 22 mmHg (30 cmH₂O)
 Visual changes, papilledema, or other focal objective neurological symptoms, headaches only if severely disabling
 No contradictions to dual antiplatelet therapy

Minor criteria (one required for qualification)

Intolerance to repeated lumbar puncture or lumbar drain
 Diagnosis of dural sinus stenosis $\geq 50\%$ on CT or MR venography
 Failed surgical shunting procedure or failed optic nerve fenestration
 Pulsatility seen on manometry which is attenuated after stenosis
 Patient preference

MR: magnetic resonance

as Wallstent (Boston, Tokyo) and Precise (Johnson & Johnson). To our knowledge, there is no report concerning percutaneous transluminal angioplasty (PTA) alone. In out-patient, also, restenosis occurred readily after PTA alone. Sustained dilation of the sinus wall cannot be attained by PTA alone. Although there is no recommendation about an appropriate stent diameter, there seems to be no problem in selecting stents according to the normal sinus diameter on both sides of the site of stenosis. Antiplatelets were used in all previous reports. DAPT is considered necessary according to the diagnostic criteria of Teleb et al.,²⁾ and we also performed DAPT from 1 week before surgery based on the perception that the venous sinus is a high-flow vessel. Headache observed for about 1 week after surgery is considered to be due to pain of dural extension caused by stent placement.⁹⁾ It has been reported to occur in the ipsilateral parietal region and to resolve spontaneously.⁹⁾ It clearly differs from headache caused by intracranial hypertension and can be differentiated easily.

Although stent placement is an effective treatment for intracranial hypertension due to transverse sinus stenosis, it has not been accepted widely as some cautious persons consider that its long-term benefits have not been established.¹⁰⁾ This treatment has the following problems. First, the pathogenic mechanism of acquired transverse sinus stenosis unaccompanied by space-occupying lesions is unknown, and whether or not the stent sustains effective dilation over a long period is unclear. Second, the duration of DAPT is uncertain. Since many patients are young, long-term DAPT may increase the incidence of hemorrhagic complications. Third, it is difficult to surgically remove the stent while CSF shunts are removable. Despite these unresolved problems, the treatment is undoubtedly good news for patients with refractory intracranial hypertension. There is a positive view that this treatment has begun to attract attention during the last 10 years,¹¹⁾ and

Ahmed et al. reported satisfactory therapeutic results with symptomatic improvements in 49 of the 52 patients with intracranial hypertension by this treatment.⁹⁾

In addition, comparison from the viewpoint of the medical cost indicated that stent placement is more economic than CSF shunting.¹²⁾ Therefore, stent placement is considered to be a treatment worth attempting in patients not responding to internal treatment or CSF shunting.

Conclusion

We reported a case of intracranial hypertension in which symptomatic improvement was achieved by stent placement via the transvenous approach. This treatment may be recommended for patients poorly responding to medical treatment or CSF shunt placement. Measurement of the venous pressure is indispensable for the evaluation of its indications.

Disclosure Statement

The first author and coauthors have no conflicts of interest.

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