Idiopathic intracranial hypertension: 12 cases treated by venous sinus stenting

J N P Higgins, C Cousins, B K Owler, N Sarkies, J D Pickard

Background: The high pressures documented in the intracranial venous sinuses in idiopathic intracranial hypertension (IIH) could be the result of focal stenotic lesions in the lateral sinuses obstructing cranial venous outflow.

Objective: To explore the relation between venous sinus disease and IIH.

Methods: 12 patients with refractory IIH had dilatation and stenting of the venous sinuses after venography and manometry had shown intracranial venous hypertension proximal to stenoses in the lateral sinuses. Intrasinus pressures were recorded before and after the procedure and correlated with clinical outcome.

Results: Intrasinus pressures were variably reduced by stenting. Five patients were rendered asymptomatic, two were improved, and five were unchanged.

Conclusions: The importance of venous sinus disease in the aetiology of IIH is probably underestimated. Lateral sinus stenting shows promise as an alternative treatment to neurosurgical intervention in intractable cases.

METHODS

Patients

Twelve patients, all female, mean age 33 years (range 19 to 52), were referred to, or were already under the care of, the neurosurgical service at Addenbrooke’s Hospital with a diagnosis of IIH. Patients had been diagnosed with IIH if they presented with a syndrome of raised intracranial pressure without ventricular enlargement or an intracranial mass on imaging, with no evidence of venous sinus thrombosis, and with normal CSF constituents.

All patients had documented raised CSF pressure (>25 cm H2O), although in some cases this had been several years previously. Seven patients had had lumbar CSF infusion studies. All patients had had brain computed tomography (CT) or magnetic resonance imaging (MRI) or both, and magnetic resonance venography (MRV).

All patients had intractable headaches and visual disturbance, the duration of symptoms ranging from five months to 12 years. Two patients had severe visual loss. Eight patients had papilloedema, in three described as chronic. In four patients papilloedema had resolved. All had previously received medical treatment under neurological supervision. Most had had repeated lumbar punctures. Five had had CSF drainage procedures (lumboperitoneal or ventriculoperitoneal shunting). One patient had had optic nerve sheath fenestration and bilateral subtemporal decompressions (table 1). None of these surgical procedures had been done less than 10 months before stenting.

Arteriography, venography, and manometry

All patients had bilateral carotid angiography under local anaesthesia using standard techniques. Cerebral venography and manometry were done, also under local anaesthesia, using a coaxial microcatheter supported by a guide catheter positioned in the internal jugular veins from a common femoral puncture. Pressure measurements were taken throughout the venous sinuses using a transducer referenced to zero at the level of the mid-axillary line.

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VENOUS SINUS STENTING

Stenting was done under general anaesthesia. A guide catheter was directed into the lateral sinus, usually from a percutaneous jugular puncture, and the stent deployed across the stenosis supported by a guide wire (fig 1). In two patients two overlapping stents were deployed on one side. Ten patients had one side only treated. Two patients (cases 2 and 3) had a second stent placed in the contralateral lateral sinus in a subsequent procedure. Patients were heparinised during the procedure; this was subsequently converted to warfarin, and then to low dose aspirin after eight weeks. In one patient with a thrombophilic disorder, anticoagulation in the long term was recommended. Follow up venography and manometry were usually undertaken once anticoagulation was discontinued.

OUTCOME ASSESSMENT

Except for one patient (case 10) who had gone back to her country of origin, all patients have been kept under ophthalmology review (NS) and under review in a dedicated neurosurgical CSF clinic (JDP). Patients were assessed at 8–12 weeks, around the time of their follow up venogram, and thereafter in clinic.

With respect to symptoms, patients broadly fell into three categories:

- Asymptomatic: resolution of headache and visual symptoms.
- Improved: some residual headache and/or visual symptoms not requiring further intervention.
- No change: no change in headache or visual symptoms.

The outcome of papilloedema is detailed in table 2.

RESULTS

There were no complications from the catheter studies. After stenting, patients usually suffered headache lateralised to the treated side which settled over days to weeks. Two patients complained of transient partial hearing loss on the stented side and one of unsteadiness, all settling within a few days or weeks.

Of 12 patients treated, five have been rendered asymptomatic, two have improved but have residual headache, and five are unchanged (table 2). One patient (case 2), who was improved after treatment, had a second stent placed several months later on the contralateral side with further improvement, but she remains symptomatic. One patient (case 3) who was unchanged after a first procedure subsequently had a stent placed in the contralateral side with initial improvement which was not sustained. No patient deteriorated after stenting. No patient who was asymptomatic or improved at 8–12 weeks has since regressed.

All 12 patients had had papilloedema documented at some stage in their illness. Eight patients still had papilloedema at the time of stenting, and it resolved after stenting in four (in two patients rendered asymptomatic and in two patients who were improved). In one patient (case 4) papilloedema was documented as improved and the patient became asymptomatic. In two patients papilloedema was unchanged; both these patients were symptomatically also unchanged. In one patient (case 10), who was rendered asymptomatic, formal ophthalmic assessment was not done before she went abroad.

Many patients had developed a severe aversion to lumbar puncture by the time they were being considered for active intervention which meant that a systematic approach to CSF pressures was impossible. One patient treated abroad for several years refused lumbar puncture under our care. Another patient (case 2) had infusion studies before and after stenting. In this patient, in whom papilloedema had resolved but who had some residual headache, the opening pressure fell from 21 mm Hg before treatment to 14 mm Hg afterwards. Other patients had had variably raised CSF pressures (sometimes documented in infusion studies) in the months or years before treatment which were not repeated immediately before stenting. In these cases the minimum likely CSF pressure could be inferred from the venous study. Only one patient (case 2) has had a lumbar puncture after stenting.

Five patients had already had CSF diversion procedures before stenting, and three had had several. Four patients had lumbo-peritoneal shunts in situ. These had given useful symptom control for a period but then had probably stopped functioning. In these cases minimum CSF pressures before and after stenting could probably be inferred from the venous catheter studies. Two patients had functioning ventriculo-peritoneal shunts, with CSF pressures maintained near normal levels but with inadequate symptom control. In these cases intracranial venous pressure might not reflect CSF pressures.

Intracranial pressure readings were used to guide stent placement at the time of the procedure. However, these pressures and the pressure gradients along the lateral sinuses were changed in an unpredictable fashion with the patient under general anaesthesia from those measured with the

Table 1 Demographic data on the patients

<table>
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<tr>
<th>Case No</th>
<th>Age (years)</th>
<th>BMI (kg/m²)</th>
<th>Duration of symptoms (years)</th>
<th>Previous procedures</th>
<th>Symptoms</th>
<th>Visual symptoms</th>
<th>Papilloedema</th>
<th>Last documented CSF pressure (cm H₂O)</th>
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<td>30</td>
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<td>41</td>
<td>12</td>
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<td>Decreased acuity, constricted fields</td>
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<td>31 (before VPS)</td>
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BMI, body mass index; BSTD, bilateral subtemporal decompressions; LP, lumbar puncture; LPS, lumbo-peritoneal shunt; ONSF, optic nerve sheath fenestration; VPS, ventriculo-peritoneal shunt.
cerebral venography with pressure recordings (manometry) before and after stenting. Some patients had more than one venogram after stenting because of concern over stent patency in the immediate postoperative period. In all these cases the stent was patent, although in two cases thrombolytic treatment was initiated because of intraluminal thrombus. This resolved with treatment, which was accompanied by clinical improvement. In all patients a reduction in intrasinus pressure was achieved, although this was not necessarily accompanied by clinical improvement (table 2). In one patient (with a ventriculoperitoneal shunt in situ), this reduction was marginal. She remained symptomatic (case 6).

DISCUSSION
With IIH partly defined as a condition of unknown aetiology, the radiological investigation of suspected cases is directed towards excluding known causes of raised intracranial pressure.1 CT or MRI will rule out hydrocephalus or a space occupying lesion; catheter angiography or MRV will rule out venous sinus thrombosis.14 Patients with the characteristic clinical features are diagnosed with IIH once these investigations are found to be normal.

The diagnosis of IIH is therefore founded on the accuracy of the radiological investigations in eliminating alternative pathologies. This accuracy is uncontested regarding the exclusion of an intracranial mass but may be an issue with respect to venous sinus disease. This is pertinent because cerebral venous sinus thrombosis or venous outflow obstruction can cause a syndrome clinically indistinguishable from IIH, and only the radiology may differentiate between them.7 MRV has largely replaced catheter angiography here and, in respect of the superior sagittal sinus, produces images that are widely regarded as diagnostic and easy to understand. The lateral sinuses are more difficult, however, with flow gaps and variations in normal anatomy confounding interpretation—a problem not usually resolved with conventional angiography.15 16

Recently several groups have circumvented these problems by undertaking catheter studies in the venous sinuses (cerebral venography) and recording intrasinus pressures (manometry).91 0 These groups have documented high pressures in the venous sinuses in patients with IIH, occasionally secondary to systemic venous hypertension but more often apparently the result of stenotic lesions of the venous sinuses, particularly bilateral lateral sinus lesions, causing partial obstruction to cranial venous outflow. This has led some investigators to propose intracranial venous hypertension as the final common pathway in the aetiology of IIH.10

These studies are open to varied interpretations, however. The walls of the venous sinuses are compliant and may deform under pressure. Osterholm17 and Johnston and Rowan18 have shown in the clinical and experimental setting that once intracranial pressure—raised by an intracranial mass lesion—rises above a certain level, pressure in the superior sagittal sinus may also rise owing to secondary collapse of the transverse sinuses. This phenomenon is reversible, with venous hypertension resolving if intracranial pressure is relieved, for example, by craniotomy. High pressures measured in the superior sagittal sinus and the pressure gradients observed along the lateral sinuses in IIH might therefore be a consequence of raised intracranial pressure rather than its cause.

King et al have examined this further.11 They found that withdrawing CSF in patients with IIH during cerebral venography (and thereby reducing intracranial pressure) eliminated, or virtually eliminated, the pressure gradients in the lateral sinuses and intracranial venous hypertension.

Figure 1  (A) Oblique lateral subtracted venogram of the lateral sinuses. Guide catheter (G) is in the left internal jugular vein. A smaller catheter enters the left sigmoid sinus and crosses the stenosis (arrows) in the left transverse sinus. The right transverse sinus is hidden from view but the right sigmoid sinus and right internal jugular vein are seen. (B) Similar view (unsubtracted) showing guide wire passing through the stent (arrows), deployed at the level of the stenosis. (C) Same view as (B) subtracted venogram showing the site of the stenosis (arrows) dilated by the stent, with good flow through the left lateral sinus.
They concluded that intracranial venous hypertension in IIH was largely irrelevant because it was secondary to raised intracranial pressure, and that the cause of raised intracranial pressure remained unsolved. But is this justified? It is widely understood that raised intracranial pressure caused by unequivocal cerebral venous thrombosis is relieved by CSF diversion.19 If such a procedure were accompanied by a trend towards a greater reduction in pressure or lower pressures reductions and symptom relief, although there was a sometimes limited efficacy of current neurosurgical management of refractory IIH it is too early to say. Much will depend on the pathology of the anatomy, pressure gradients along both lateral sinuses were necessarily similar but most patients had only one side treated; often leaving a small residual gradient that might account for persistent symptoms.

What role stenting might have in the treatment of refractory IIH it is too early to say. Much will depend on the stability of the result, given the known tendency for restenosis around intravascular stents at other sites.20 21 Regardless of this issue, however, with the morbidity and

<table>
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<th>Case No</th>
<th>Torcular</th>
<th>Jugular bulb</th>
<th>Torcular</th>
<th>Jugular bulb</th>
<th>Symptoms</th>
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<th>Follow up (months)</th>
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</table>

The last column indicates total subsequent clinical follow up.
†Papilloedema resolved before stenting.
of venous outflow obstruction should encourage a revision of current concepts of IIH and its relation to venous sinus disease and sinus thrombosis.

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