



# Endovascular Treatment of Idiopathic Intracranial Hypertension Secondary to Venous Stenosis

## *Tratamento endovascular da Hipertensão Intracraniana Idiopática Secundária à Estenose Venosa*

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### Abstract

**Introduction** Idiopathic intracranial hypertension (IIH) is a condition characterized by signs and symptoms of elevated intracranial pressure (ICP). Although the role of venous sinus stenosis in the pathophysiology of IIH is controversial, venous angioplasty with stenting has been proven to decrease cerebral venous pressure and intracranial pressure. This study aims to identify and quantify the clinical improvement obtained by patients with IIH, refractory to prior pharmacological treatment, undergoing endovascular venous angioplasty in a neuroendovascular reference service.

**Methods** A retrospective analytical study of 25 cases of IIH with transverse sinus stenosis operated on in a reference service using the endovascular method, in which clinical data from medical records and information about the procedure were analyzed.

**Results** Of the 25 patients, 22 were women, and the mean age was 42 years. All patients were refractory to prior clinical treatment. At the clinical presentation, all had headaches. There were no complications or failures from the procedures performed. In the 30-day evaluation, there was a significant decrease in all the symptoms reported.

**Conclusion** Venous sinus stenting is safe and effective in patients with IIH with transverse sinus stenosis refractory to clinical treatment, with substantial symptomatic improvement and good evolution in the postoperative follow-up period.

### Keywords

- ▶ stenosis
- ▶ endovascular
- ▶ idiopathic intracranial hypertension

### Resumo

**Introdução** A hipertensão intracraniana idiopática (HII) é uma condição caracterizada por sinais e sintomas de pressão intracraniana elevada (PIC). Embora o papel da estenose dos seios venosos na fisiopatologia da HII seja controverso, a angioplastia venosa com

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**Palavras-chave**

- ▶ estenose
- ▶ endovascular
- ▶ hipertensão intracraniana idiopática

colocação de stent tem se mostrado eficaz na redução da pressão venosa cerebral e da pressão intracraniana. Este estudo visa identificar e quantificar a melhoria clínica obtida por pacientes com IIH, refratários ao tratamento farmacológico prévio, submetidos à angioplastia venosa endovascular em um serviço de referência neuroendovascular.

**Métodos** Um estudo analítico retrospectivo de 25 casos de IIH com estenose do seio transversal operados em um serviço de referência utilizando o método endovascular, no qual foram analisados dados clínicos dos prontuários médicos e informações sobre o procedimento. Resultados: Dos 25 pacientes, 22 eram mulheres, com idade média de 42 anos. Todos os pacientes eram refratários ao tratamento clínico prévio. Na apresentação clínica, todos tinham cefaleia. Não houve complicações ou falhas nos procedimentos realizados. Na avaliação de 30 dias, houve uma diminuição significativa em todos os sintomas relatados.

**Conclusão** A colocação de stent nos seios venosos mostrou-se segura e eficaz em pacientes com IIH com estenose do seio transversal refratários ao tratamento clínico, com melhoria sintomática substancial e boa evolução no período de acompanhamento pós-operatório.

**Introduction**

Idiopathic intracranial hypertension (IIH), also known as brain pseudotumor, is a condition characterized by signs and symptoms of elevated intracranial pressure (ICP) without an established pathophysiology.<sup>1</sup> It is an uncommon disorder whose worldwide incidence ranges from 1 to 3 cases per 100,000 population per year and can affect both children and adults.<sup>2</sup> This disorder is strongly associated with obesity and affects mainly female patients of childbearing age.<sup>1</sup>

The clinical picture is nonspecific, which leads to late recognition, as well as underdiagnosis. Most patients with IIH have progressive, sometimes migraine-like headaches. Common findings include papilledema, visual blurring, tinnitus, dizziness, and cognitive disturbances.<sup>2</sup>

While the role of venous sinus stenosis in the pathophysiology of IIH is controversial, venous angioplasty with stenting has been shown to decrease cerebral venous pressure and intracranial pressure by improving cerebrospinal fluid (CSF) absorption.<sup>3</sup> Currently available literature provides increasing evidence that this procedure is associated with important symptomatic relief and long-term disease control.<sup>4</sup>

This study aims to identify and quantify the clinical improvement of patients with IIH who are refractory to prior pharmacological treatment and underwent endovascular venous angioplasty in a neuroendovascular reference service. Moreover, the study seeks to develop the epidemiological profile and survey the main comorbidities in patients with IIH, as well as symptoms, prior treatments, stenosis characteristics, materials used in surgery, and surgical success rate and complications.

**Methods****Design and Sample**

This is a retrospective analysis of 25 cases of IIH with transverse sinus stenosis operated on using the endovascular

method in a neurosurgery reference service in Blumenau - SC, Brazil.

**Inclusion and Exclusion Factors**

Symptomatic individuals diagnosed with IIH according to Dandy's criteria, with transverse sinus stenosis shown on venography and undergoing endovascular stenting between August 2015 and August 2023 were included. Insufficient medical data, such as segment loss and absence of radiological reports, were considered exclusion factors.

**Data Analysis**

Based on clinical data from medical records, information on the endovascular procedure and radiological findings in the reports, we calculated sums and the percentage of patients who matched each of the variables analyzed in the study. Results concerning symptomatology data were temporally compared to measure the decrease in their absolute values 30 days after the surgical intervention. The analyses were tabulated and calculated using Microsoft Excel 2020®.

**Variables**

The variables studied were sex, age, prior comorbidities, clinical presentation, prior treatment, location and degree of venous stenosis, diagnostic tests, stent used in the endovascular intervention -Casper® (Microvention™, Schnapper 78100 Saint-Germain-en-Laye France), Precise (Cordis®, 14201 Northwest 60th Avenue Miami Lakes, USA) and Carotid Wall (Boston Scientific™, 300 Boston Scientific Way Marlborough, MA 01752-1234, USA)-, balloons selected for the dilation of the Falcon RX stent (Scitech Medical Products®, Rua 18, Lote 06 Polo Empresarial Goiás, state of Goiás, Brazil), Aviator Plus (Cordis®, 14201 Northwest 60th Avenue Miami Lakes, USA), Viatrac 14 Plus (Abbot®, 100 Abbot Park Road, IL, 60064, USA) and Sterlin (Boston Scientific™, 300 Boston Scientific Way Marlborough, MA 01752-1234, USA), complications and post-procedure evolution.

## Procedure

All patients were started on dual antiaggregation therapy with aspirin 200 mg daily and clopidogrel 75 mg, 1 week prior to the procedure. They remained on dual antiaggregation for 3 months and are still on 100 mg of aspirin continuously.

Initially, total sedation and heparinization were performed, with instillation of intra-arterial and intra-venous low osmolarity non-ionic contrast, femoral artery through a guide catheter. Next, cerebral angiographies were performed to establish the location and degree of stenosis, and the venous pressure was measured pre- and post-angioplasty. Using a micro-guide, a stent was inserted that fitted the stenosis level, thus correcting the affected region of the transverse sinus. Then, an Angioplasty Balloon was inflated twice for post-dilatation. Postoperative angiographies showed the correct permeability of the device.

## Ethics

The study was conducted according to SPIRIT and approved by the local ethics committee under CAEE 31683520.0.0000.5370. The Informed Consent Form (ICF) was presented and made available to all individuals who took part in the study.

## Results

Of the 25 patients, 22 (88%) were female, and the mean age of the study population was 42 (range, 12-72 years old). Obesity was found in 3 (12%) individuals. All patients were refractory to prior clinical treatment; 12 (48%) had topiramate alone, 4 (16%) had acetazolamide alone, 1 (4%) had only ventriculoperitoneal shunting (VPS); 6 (24%) were on a combination of topiramate and acetazolamide, and 2 (8%) were treated with topiramate and VPS.

At clinical presentation, 21 patients (84%) had papilledema, 1 (4%) had abducent cranial nerve (VI nerve) involvement, 9 (36%) had visual loss, 22 (88%) complained of visual clouding, 5 (20%) had tinnitus, 11 (44%) had nausea and vomiting, 2 (8%) had mental confusion, 3 (12%) had syncope, 13 (52%) had dizziness, 1 (4%) had dysphasia, 2 (8%) had memory loss, and all 25 (100%) complained of headache. As for diagnostic tests, skull MRI was performed in 7 (28%) cases, skull CT scan in 1 (4%), venous angioresonance in 22 (88%), and arteriography in 25 (100%). The mean degree of stenosis of the affected TS was 95%; 6 (24%) patients had bilateral stenosis and 2 (8%) had occlusion of the contralateral TS (► **Table 1**).

The stents used were Casper in 23 (92%) patients, Precise in 1 (4%), and Carotid Wall in 1 (4%). The balloon used was Falcon RX in 16 (64%) cases, Aviator Plus in 5 (20%), Viatrac 14 Plus in 3 (12%) and Sterlin in 1 (4%). Femoral surgical access was chosen in all interventions. No complications or failures were observed in the procedures performed.

In the 30-day evaluation, we found a 78% decrease in papilledema, 44% in visual loss, resolution of 50% of visual clouding symptoms, 60% in tinnitus, 63% in emesis, 84% in dizziness, and a 72% decrease in headache complaints. There was a complete remission of confusion, syncope,

and memory loss. The mean opening pressure on lumbar puncture before venoplasty was 27.68 cmH<sub>2</sub>O, and after venoplasty it was 5.84 cmH<sub>2</sub>O, with a mean decrease of 78.17% from the level found at clinical presentation (► **Table 2**; ► **Figs. 1–6**).

## Discussion

Previously called “benign intracranial hypertension”, which expressed the absence of tumors and frequent clinical remission, this disorder was renamed to portray its association with severe morbidities, such as permanent visual loss.<sup>5</sup> It predominantly affects women, who, according to the figure found in this study (88%), make up about 90% of the population with IIH.<sup>4</sup> The mean age at diagnosis is about 30,<sup>5</sup> an age slightly lower than that found in the study sample (42).

In the literature, there are reports of visual clouding (68%) and pulsatile tinnitus (58%) in patients with IIH. In our sample, the prevalence was 88% and 20%, respectively, showing lesser importance of tinnitus at clinical presentation. Headache is the most common symptom, with a prevalence of 93% according to surveys, routinely characterized as severe daily pulsatile pain. In this study, this symptom was also the most prevalent, found in all (100%) patients. The estimated prevalence of visual loss is 30%, similar to what was observed in this sample (36%). Papilledema is often considered a defining sign of IIH, with an incidence of 95%, also close to the rate found in this study (86%). Abducent nerve palsy is limited to severe cases, seen in 1 of our patients.<sup>4</sup>

IIH pathogenesis is not fully understood. Dural venous sinus occlusion secondary to thrombosis or compressive injury, most commonly in the transverse sinus (TS), is known to lead to increased ICP and IIH. However, primary TS stenosis has been increasingly identified in patients with IIH,<sup>6</sup> with incidences ranging from 30% to 93%<sup>4</sup> compared with 6.8% in the general population.<sup>7</sup> Some consider such alteration to be the underlying cause of IIH, although its possibly being a consequence of refractory disease is still in discussion.<sup>3</sup>

Other contributing factors to its pathophysiology are also considered, such as overweight or obesity and hormonal disorders.<sup>2</sup> Higher increased intra-abdominal and cardiac filling pressures found in obese individuals hinder cerebral venous return, leading to increased ICP.<sup>8</sup> Several epidemiological studies found that 80-90% of IIH patients have some degree of obesity,<sup>9</sup> an estimate that is higher than the value found in this sample, of only 12%.

IIH is a diagnosis of exclusion, usually established based on the modified Dandy criteria, which include elevated ICP (> 25 cm H<sub>2</sub>O on lumbar puncture, performed in lateral decubitus), with papilledema typically present (not a mandatory criterion, though), and normal neuroimaging and CSF.<sup>5</sup> No individuals in this study had changes in neuroimaging, and all of them had opening pressure on initial lumbar puncture above 25cm of H<sub>2</sub>O, the average being 27.68. There is research work describing a higher mean value, around 40cm of H<sub>2</sub>O,<sup>8,10</sup> but with a smaller patient sample.

**Table 1** Characteristics of patients undergoing endovascular therapy for IIH

Variable	Classification	n	Percentage (%)
Sex	Female	22	88%
	Male	3	12%
Age	Mean	42	
	Under 40	12	48%
	Over 40	13	52%
Prior clinical treatment	Topiramate	12	48%
	Acetazolamide	4	16%
	VPS	1	4%
	Acetazolamide + Topiramate	6	24%
	Topiramate + VPS	2	8%
Clinical Presentation	Headache	25	100%
	Papilledema	21	84%
	Visual Clouding	22	88%
	Nausea/Vomiting	13	52%
	Visual loss	11	44%
	Tinnitus	9	36%
	Syncope	5	20%
	Mental confusion	3	12%
	Memory loss	2	8%
	Dysphasia 6th nerve involvement	2 1	4% 4%
30-dayevaluation	Papilledema	–	78% decrease
	Visual loss	–	44% decrease
	Visual Clouding	–	50% decrease
	Headache	–	72% decrease

There are no widely accepted standardized guidelines for treating IIH.<sup>8</sup> The main therapeutic goals are lowering ICP and resolving potential etiologic factors, through which symptomatic relief and vision preservation will be achieved. Weight loss, medication use, serial lumbar punctures, VPS, bariatric surgery, and venous angioplasty are alternatives currently used for this purpose.<sup>11</sup>

The most widely used drug for clinical treatment is acetazolamide, a carbonic anhydrase inhibitor that reduces CSF production in the choroid plexus and, therefore, decreases ICP. Topiramate has similar effects and promotes weight loss.<sup>12</sup> Both drugs have potential side effects that include allergic reactions, fatigue, paresthesia, nausea, vomiting, cognitive impairment, and teratogenicity, which cause a significant percentage of patients to discontinue therapy.<sup>2</sup> The authors of a Cochrane review based on two randomized clinical trials conducted to study the effect of acetazolamide

versus placebo were unable to recommend or reject acetazolamide for the treatment of IIH.<sup>13</sup>

Patients who develop rapid progression of visual loss, are clinically refractory, or present with severe acute symptoms require urgent temporary measures such as repeated lumbar puncture, cerebrospinal fluid drainage, or optic nerve sheath fenestration (ONSF). It is known that such management options are not definitive treatments; moreover, these measures are associated with multiple complications such as orbital cellulitis, traumatic optic neuropathy, drain obstruction, subdural hemorrhages, and tonsillar hernia, according to the procedure that is performed.<sup>12</sup>

Based on recent pathophysiological concepts, venous sinus stenting has been widely recommended as a safe method to prevent sequelae and restore CSF drainage.<sup>10</sup> Knowing that venous stenosis and the ensuing elevation of ICP may play a role in IIH etiology, it can be proposed that the

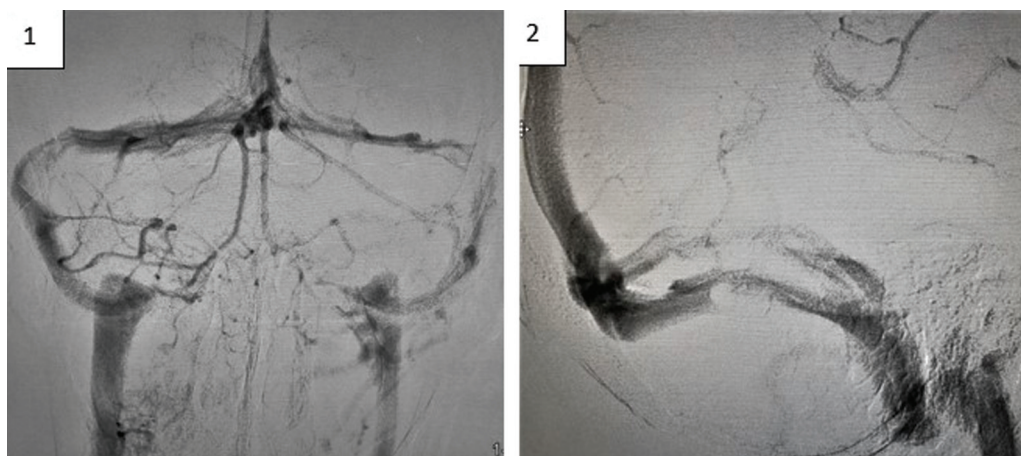
**Table 2** Variation from pre- to post-stenting venous pressures

N°	Pre-stenting venous pressure	Post-stenting venous pressure	Decrease (%)
1	50	4	92.0%
2	30	5	83.3%
3	24	6	75.0%
4	24	6	75.0%
5	25	5	80.0%
6	42	7	83.3%
7	32	4	87.5%
8	28	5	82.1%
9	26	6	77.0%
10	24	7	70.8%
11	21	10	52.4%
12	20	4	80.0%
13	16	3	81.2%
14	19	2	89.5%
15	28	12	57.1%
16	55	14	74.5%
17	15	3	80.0%
18	32	4	87.5%
19	23	6	74.0%
20	28	5	82.1%
21	25	6	76.0%
22	22	7	68.1%
23	24	4	83.3%
24	30	5	83.3%
25	29	6	79.3%

most appropriate intervention for a patient with identified venous sinus stenosis is one that acts directly on its hemodynamics, through stenting. Other surgical options, such as ONSF and VPS, decrease CSF pressure; however, they do not

act directly on venous sinus hemodynamics and, therefore, may not modulate the underlying cause of the problem.<sup>5</sup>

There are favorable data in the literature on the efficacy of venous sinus stenting. A systematic review and meta-

**Fig. 1-2** Pre-Stenting exams for evaluation of Stenosis.





**Fig. 3–6** Post-Stenting exams for procedure evaluation.

analysis of data from 473 patients in 24 trials concluded that this procedure is associated with lower ICP, improved symptoms, and low complication rates in patients with refractory IIH and evidence of venous sinus stenosis.<sup>14</sup> Likewise, a systematic review of data from 185 patients who had undergone stenting suggested that this method may be a safe and effective therapeutic option for IIH refractory to clinical treatment.<sup>15,16</sup>

As for the patients in this study, a lower ICP (observed through lower opening pressure on the post-procedure lumbar puncture), as well as a substantial remission of complaints,

were achieved after venous angioplasty with stenting in the transverse sinus in cases already refractory to prior therapeutic attempts. The absence of surgical complications and a favorable evolution after the intervention show that this approach yields promising results, especially in patients unresponsive to medication, with contraindications to their use, or with greater clinical severity.

## Conclusion

This study shows that venous sinus stenting is safe and effective in patients with IIH and with transverse sinus stenosis refractory to prior treatment, with significant symptomatic improvement and good evolution during the post-operative follow-up period. Accordingly, the literature has shown that this therapeutic approach achieves good outcomes. However, further studies are needed to provide prospective data and evaluate its long-term clinical outcomes.

## Conflict of Interest

None declared.

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