CASE REPORT

Endovascular Treatment of Pulsatile Tinnitus Caused by Dural Sinus Stenosis

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ABSTRACT—A patient presenting with progressive pulsatile tinnitus was found to have an ipsilateral dural sinus stenosis. This problem was successfully treated by an endovascular approach with angioplasty and subsequent sinus stenting. The diagnostic evaluation, therapeutic method, and follow-up concerning this problem and its treatment are discussed.

Dural venous sinus stenosis was discovered during diagnostic angiography as the cause of severe, progressive pulsatile tinnitus in a young female patient. Endovascular therapy, utilizing balloon angioplasty and stenting, eliminated the patient's tinnitus. This treatment option is important to be considered because surgical therapy for this unusual cause of pulsatile tinnitus can be complex and may be associated with significant complications.

CASE HISTORY

A 29-year-old female was referred for evaluation of left pulsatile tinnitus of 7 months duration. The tinnitus (somatosounds) had gradually increased in intensity to the point of severely disturbing sleep and concentration. Generalized headaches also developed during this interval. Past medical history was significant only for hysterectomy and bilateral oophorectomy for benign disease 4 years prior to this admission. A previous workup included a normal MRI of the brain and skull base.

The physical examination revealed a mildly obese female who was clearly disturbed by her symptoms. She had normal tympanic membranes with no sign of mass or effusion. Auscultation of the head and neck failed to demonstrate audible bruit. However, 3 weeks after the initial exam, the pulsatile tinnitus became louder to the patient and a bruit was then easily detected with a stethoscope over the left temporal and postauricular area. The tinnitus was transiently diminished by manual, ipsilateral jugular vein compression and accentuated following pressure release. No neurologic deficits were present.

Neuro-ophthalmologic examination was normal with no evidence of papilledema. An audiogram was normal with thresholds of 15db or better. Benign intracranial hypertension was suspected and a lumbar puncture performed; a high normal opening pressure of 18 cm H_2O was measured and dropped to 14 cm H_2O with the removal of 5 cc of CSF. The tinnitus transiently diminished after the lumbar puncture.

A diagnostic cerebral angiogram revealed no evidence of dural AV fistula, arteriovenous malformation, or arterial stenosis. However, there was stenosis at the left transverse-sigmoid sinus junction (Fig. 1A-1D). A microcatheter placed via the jugular route across the stenosis revealed a pressure gradient of 15 mmHg. The right transverse sinus was small or hypoplastic by comparison and therefore had a relatively small effluent venous flow.

Following extensive consultation with the patient and associated clinical teams, an endovascular treatment of the stenosis was elected, with subsequent placement of a 7 French jugular sheath. A 5 French diagnostic catheter was advanced across the stenosis and a venogram obtained to better evaluate the stenotic area (Fig. 1C, 1D). An 0.038 inch Amplatz wire was left across the stenosis and the 5 French catheter was replaced by an Olbert (Meadox Surgimed; Oakland, CA) 10 mm/4 cm angioplasty balloon. Balloon inflation of only 5–6 atmospheres of pressure was adequate to completely dilate the stenosis. The patient immediately complained of severe headache which resolved instantly with rapid deflation of the balloon. The

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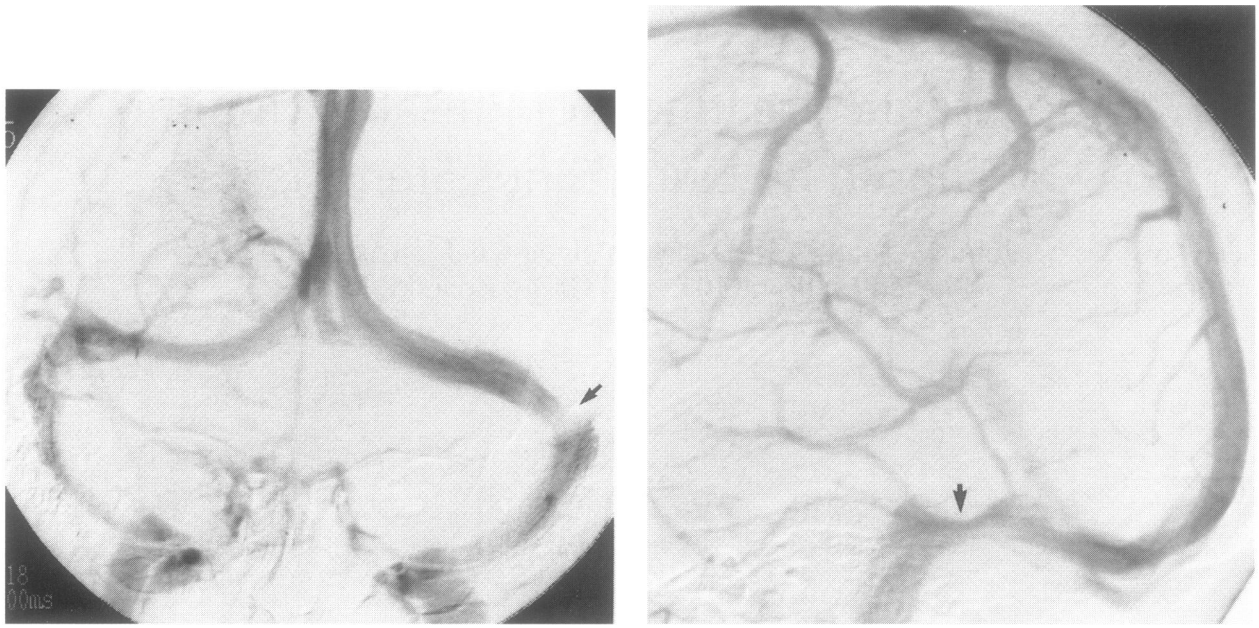
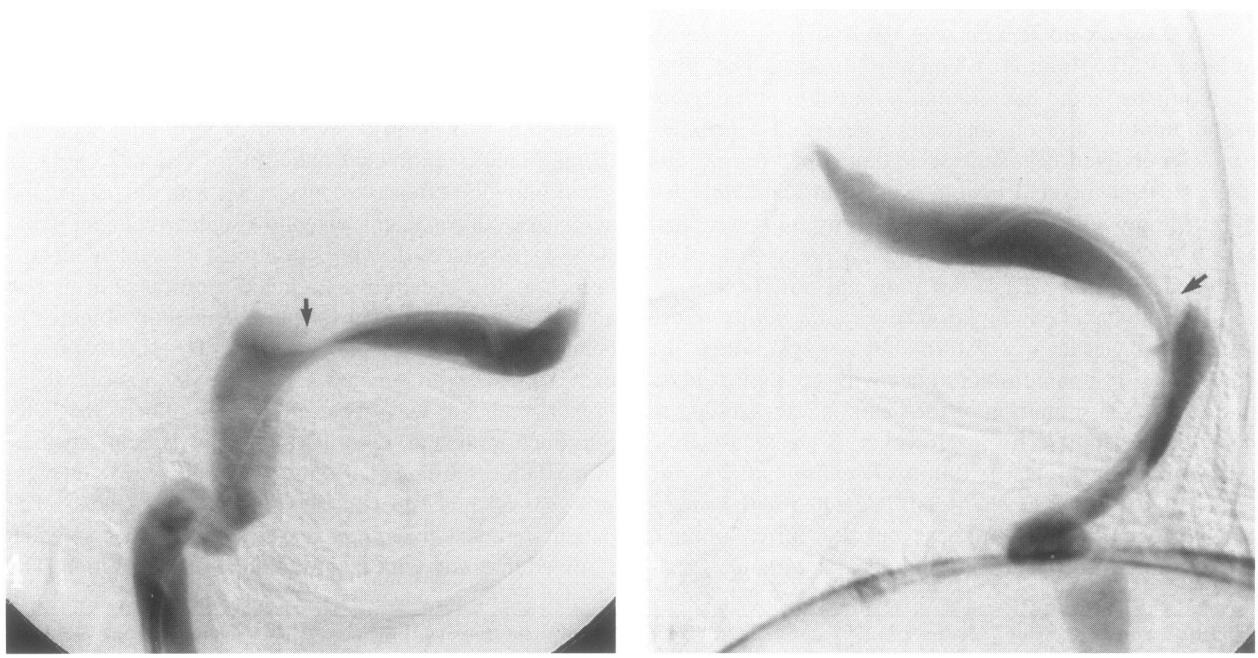


Figures 1A and B. PA and Lateral venous phase images of a diagnostic cerebral angiogram. These suggest stenosis in the region of the left transverse-sigmoid sinus junction (arrows). This finding coupled with the patient's clinical symptoms in this region initiated venous endovascular pressure measurements above and below the area of suspected stenosis.

patient's tinnitus was reduced but the effect was transient, and a subsequent venogram demonstrated the stenosis was only mildly diminished by the balloon dilation.

The patient had experienced considerable discomfort during passage of the angioplasty balloon through the jugular bulb using only conscious neuroleptic sedation. Therefore, general anesthesia was induced prior to stent placement. A 12 mm by 4 cm Wallstent (Schneider Medical, Minneapolis, MN) was introduced coaxially via a left internal jugular approach and deployed across the transverse-sigmoid sinus junction (Fig. 1E). This completely relieved the dural sinus stenosis (Figs. 1F, 1G). The



Figures 1C and D. Lateral and PA images of a left transverse sinus venogram. This examination better demonstrates the degree of anatomic stenosis at the left transverse-sigmoid sinus junction (arrows).

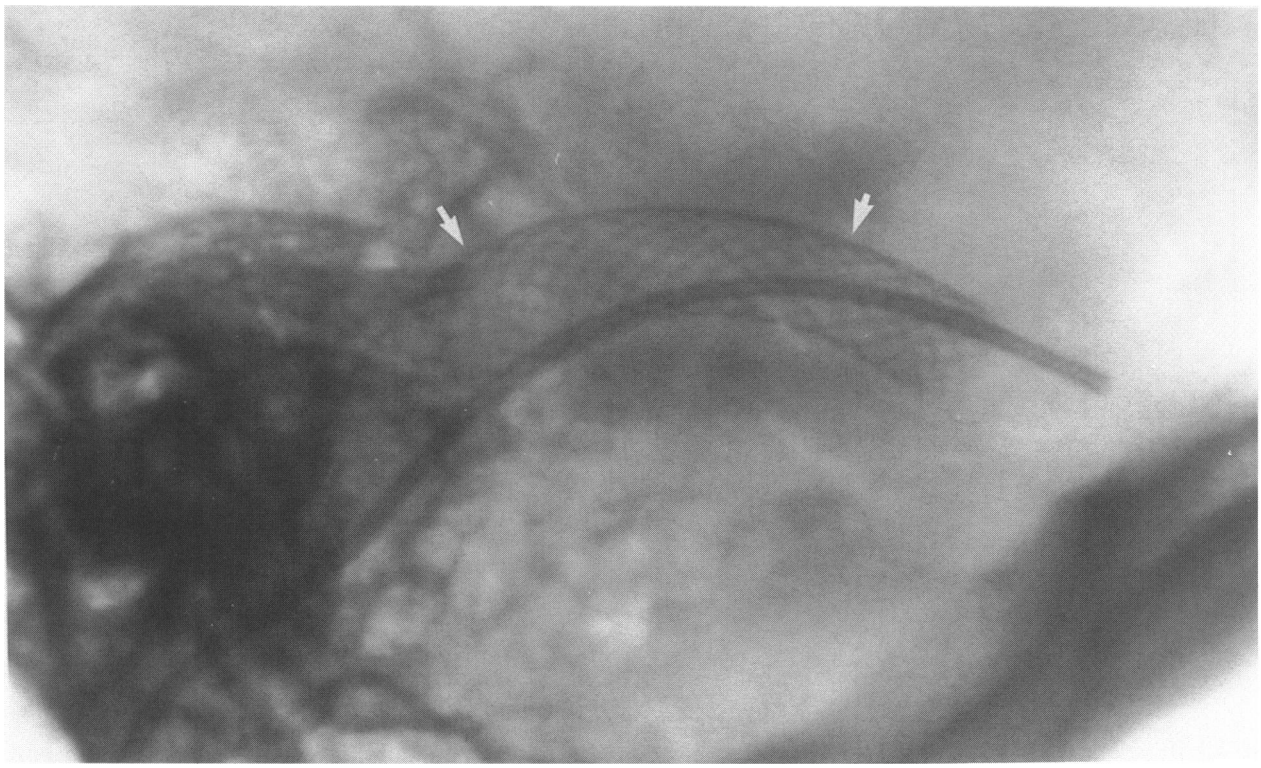


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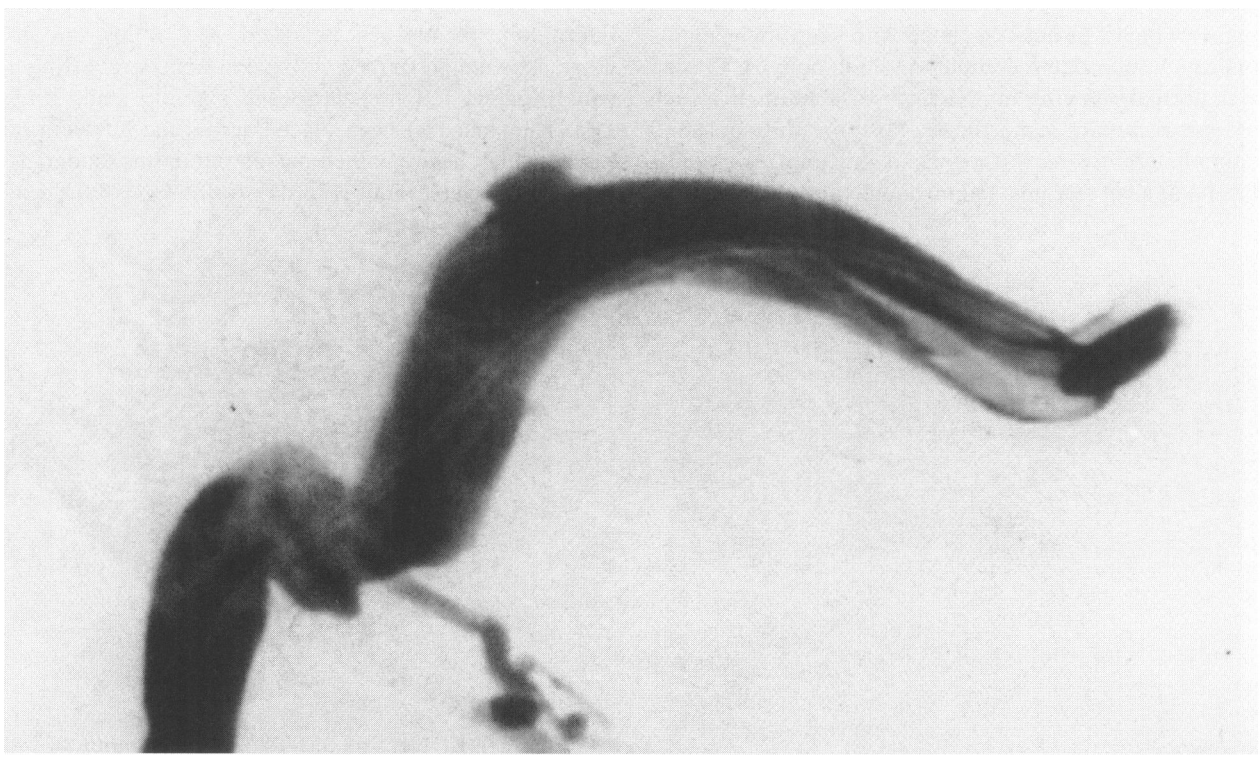
Figure 1E. Lateral image from a skull radiograph showing a Wallstent (arrows) after deployment placed across the stenosis in the left transverse-sigmoid sinus.



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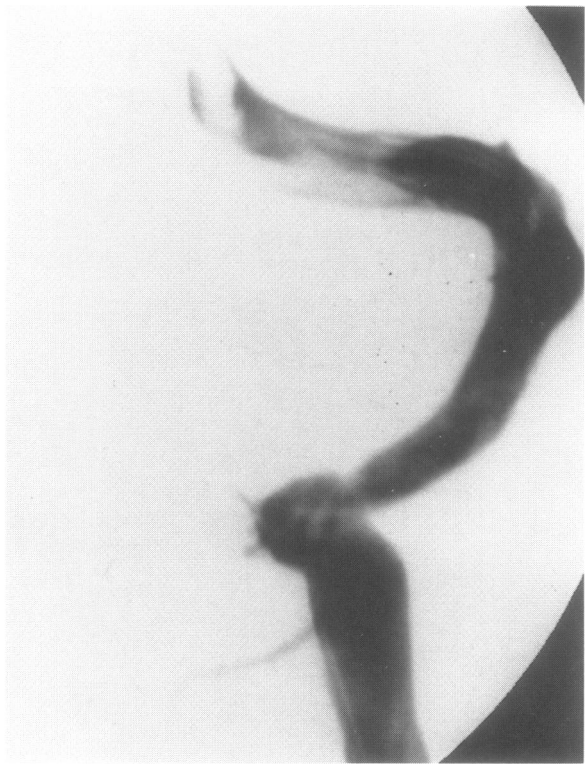
Figures 1F and G. Lateral and PA views of a left transverse sigmoid sinus venogram after stent deployment show a widely patent sinus and obliteration of the stenosis at the transverse-sigmoid sinus junction. (Figure continued on the next page.)



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Figures 1F and G. (Continued).

patient detected no residual tinnitus upon awakening from anesthesia. She reported a discomfort in the left mastoid region which was not associated with neurologic abnormality. A subsequent computed tomography (CT) scan was normal showing no evidence of abnormality such as subarachnoid hemorrhage. Postprocedure mastoid pain, though severe, was managed with analgesics and a brief course of steroids. Pain from the mastoid had completely resolved by 2 weeks postprocedure. The patient was maintained on aspirin and Coumadin for 3 months. Intermittent headaches persisted and follow-up angiograms were performed at 3 and 8 months revealing a widely patent left transverse and sigmoid sinus (Fig. 1H). The stent had been placed across the left vein of Labbe which has remained patent and drains antegrade into the transverse sinus (Fig. 1I). At the time of the sec-

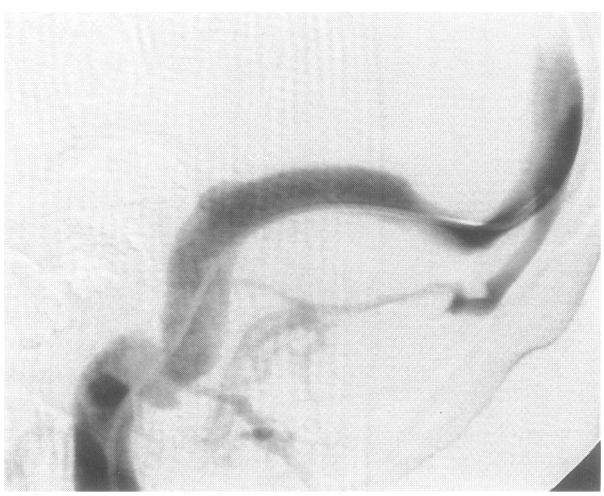

Figure 1H. Eight month follow-up venogram of the transverse-sigmoid sinus junction shows that there remains a widely patent dural sinus without appearance of re-stenosis nor significant luminal narrowing.

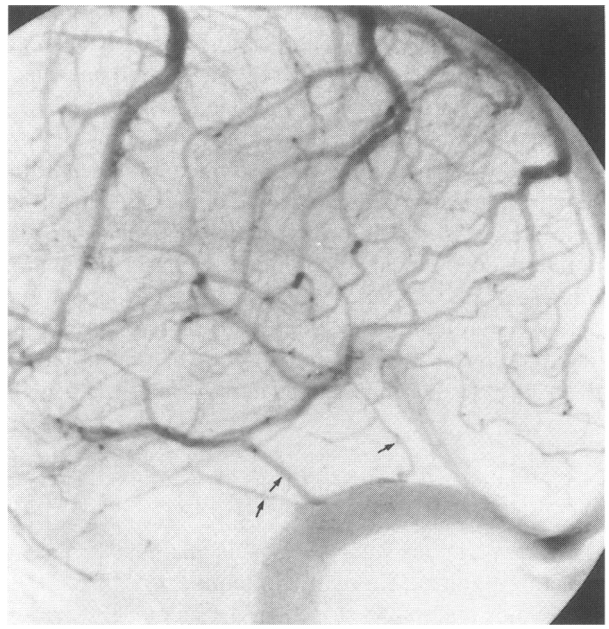

Figure 11. Lateral image from the venous phase of a cerebral arteriogram performed eight months post stent deployment. Once again we note the widely patent transverse-sigmoid sinus junction. The stent was placed across the region of the vein of Labbe. Three relatively small veins in this area enter the sinus (arrows). Patency is demonstrated and there is no change in their overall appearance from the prestenting venous phase angiogram (1B).

ond follow-up exam, the patient reported low level tinnitus which she could only hear in a quiet environment (however, not audible to auscultation).

DISCUSSION

Tinnitus is broadly divided into sensorineural and somatosounds. Sensorineural tinnitus is usually described as whistling, escaping steam, or cricket sounds and is frequently associated with sensorineural hearing loss or other otologic disease processes. Somatosounds are noises generated by structures in the tissues adjacent to the ear, and depending upon their loudness, may be heard by an examiner. Somatosounds are most often vascular in nature and characterized as pulsatile when they are rhythmic or cardiac synchromous[1,2]. Nonvascular tinnitus may be generated from noise associated with temporomandibular joint dysfunction, abnormal muscular contraction (e.g., palatal myoclonis), or a patulous eustachian tube transmitting sound from the nasopharynx to the middle ear.[3–4] Tinnitus may also be associated with elevated intracranial pressure.[5–8] Far more commonly, tinnitus is associated with turbulent blood flow in the region of the ear. This can result from increased blood flow to an arteriovenous malformation,[9–10] dural arteriovenous fistula,[12–15] or vascular tumor (e.g., paraganglioma).[16–19] Turbulence can also be created when blood flows through an area of vascular stenosis.[20–28] This is seen most often with carotid stenosis when narrowing is secondary to atherosclerotic disease[23–24] or fibrous muscular dysplasia.[26–28] However, the stenosis (and turbulent blood flow) may be found in the venous system as it was in this case. Venous origin tinnitus may also occur with a high lateral or dehiscent jugular bulb.[29–35]

Surgical interventions have been recommended in patients with venous abnormalities resulting in tinnitus if symptoms are severe enough to interfere with daily living.[13, 36–38] Test occlusion of the jugular has been used to determine the appropriate site of venous occlusion to relieve tinnitus.[13] However, interruption of a dural sinus, even temporarily with test occlusion can be dangerous and may result in venous ischemia or hemorrhage. Occlusion of the sinus with an angioplasty balloon in our patient resulted in rapid accentuation of diffuse headache which was believed to be created by transient elevation of cerebral venous pressure. This occurred within 5 seconds of full balloon inflation. Local dural stretching could create pain but would be expected to be more focal in nature. Angioplasty alone, in this case, did not provide permanent relief of the dural sinus stenosis. However, it did reveal that the stenosis was soft and easily opened by a relatively low balloon pressure. Transient elimination of the tinnitus during balloon inflation confirmed the stenosis as the etiology of the patient's complaint.

A Wallstent was selected for this patient because it is relatively flexible and capable of being placed around moderate curvatures. In the deployed state, it will conform well to tortuous anatomy without compromising luminal size. Even though angioplasty could be performed in this patient while receiving conscious sedation, there was considerable discomfort produced in manipulating the relatively stiff angioplasty catheter through the jugular bulb region. Because the stent de-

ployment device is even more rigid than the angioplasty catheter (and potentially harder to physically manipulate through the jugular bulb region) general anesthesia was induced prior to stent placement. Once deployed, the stent eliminated the venous sinus stenosis.

The local pain that this patient experienced after stent placement was not described in the case performed by Marks et al.[29] The origin of this patient's pain was probably due to local stretching of the dural sinus. Slow improvement resulted with analgesic and anti-inflammatory (steroidal and nonsteroidal) therapy. Follow-up angiography at 3 and 8 months has demonstrated patency of the sinus and the ipsilateral vein of Labbe.

CONCLUSION

Dural venous sinus stenosis is an unusual cause of pulsatile tinnitus. Surgical correction, though possible, is complex and may be associated with moderate risk or complication. Endovascular therapy offers a reasonable alternative when this type of abnormality is discovered with associated tinnitus.

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