Case Report

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Herniation of the Flocculus Cerebellaris into the Internal Auditory Canal: A Rare Anatomical Variant Mimicking a Vestibular Pathology

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Abstract

We report a rare case of herniation of the flocculus cerebellaris into the internal auditory canal (IAC) and discuss the radiologic features and clinical implications in light of the current literature. A 19-year-old male with vestibular symptoms underwent high-resolution magnetic resonance imaging (MRI), which revealed cerebellar tissue within the right IAC. Multiplanar MRI sequences showed extension of the flocculus into the IAC with no evidence of mass effect or neurovascular compression. Herniation of the flocculus cerebellaris into the IAC is a rare anatomic variant that can mimic neoplastic lesions. Awareness of this entity is critical to avoid misdiagnosis and unnecessary intervention. This case report highlights the importance of a rare anatomical variant in the differential diagnosis.

Keywords: Cerebellum, flocculus cerebelli, internal auditory canal, magnetic resonance imaging, vestıbular diseases, otology, case reports

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Introduction

The cerebellar flocculus is a small lobe in the cerebellar angle that is closely associated with the vestibular system. It contributes to the coordination of eye movements and the control of balance. Although it typically lies outside the internal auditory canal (IAC), herniation of the flocculus into the IAC is a rare radiologic finding that can simulate other pathologies of the IAC, such as a vestibular schwannoma or meningioma. The etiology remains unclear, and only a few cases have been documented in the literature (1-5). We present a case of inadvertent herniation of the cerebellar flocculus into the IAC in a patient with vertigo and provide a comprehensive review of the current literature.

Case Presentation

A 19-year-old male presented with a 3-month history of intermittent vertigo and balance disturbances. There was no history of trauma, otologic surgery, or neurodegenerative disease. The neurological examination was unremarkable. The patient's otologic examination revealed progressive sensorineural hearing loss predominantly in the right ear, accompanied by intermittent tinnitus and occasional imbalance. Audiometric examination revealed a moderate sensorineural hearing loss on the right side. Vestibular evaluation was performed using videonystagmography, including positional testing and bithermal caloric irrigation. The results revealed a mild right-sided canal paresis,

indicating unilateral peripheral vestibular hypofunction consistent with the patient's clinical symptoms. Otoscopic examination showed intact and normal tympanic membranes on both sides. High-resolution magnetic resonance imaging (MRI) of the brain and the IAC was done using a 3 Tesla system. Sequences included axial T1-weighted (T1W), T2-weighted (T2W), and three-dimensional (3D) SPACE, fluid attenuated inversion recovery, diffusion-weighted imaging, and T1W post-contrast images. The findings showed a tongue-like projection of tissue into the proximal right IAC, iso- to hypo-intense on T2W images and continuous with the ipsilateral cerebellar flocculus (Figures 1a-1d). In consecutive T2-SPACE images, the cerebellar flocculus was observed to advance its course towards the IAC (Figures 2a-2e). The tissue was not swollen. There was no diffusion restriction or pathological contrast enhancement. The cranial nerves within the IAC were preserved and not compressed. The brainstem, cerebellar hemispheres, and flocculus were otherwise unremarkable. Imaging findings were consistent with herniation of the cerebellar flocculus into the IAC. Surgical intervention was not indicated. A conservative management strategy was adopted, consisting of vestibular rehabilitation therapy, symptomatic medical treatment (including vestibular suppressants during acute episodes), and patient education. The patient was advised to avoid sudden head movements and known vertigo triggers. Regular clinical, audiometric, and radiologic follow-up was planned to monitor symptom progression and ensure lesion stability. Informed consent was obtained from the patient.

Discussion

Herniation of cerebellar structures into the IAC is a rare but increasingly recognized finding with the advent of high-resolution MRI techniques. The cerebellar flocculus, part of the vestibulocerebellum, plays a role in gaze posture and vestibulo-ocular reflexes. It is normally located in the cistern of the cerebellar angle and is separated from the IAC by the arachnoid and subarachnoid space. The mechanism underlying the herniation of the cerebellar flocculus into the IAC remains speculative. Proposed factors include congenital variants, arachnoid defects, intracranial hypotonia, cerebellar atrophy, or chronically elevated intracranial pressure (1,2). However, in most reported cases, including ours, no underlying cause has been identified.

The pathophysiologic relationship between floccular hernia and sensorineural hearing loss remains incompletely understood, but several mechanisms have been proposed. The cerebellar flocculus, when herniated into or adjacent to

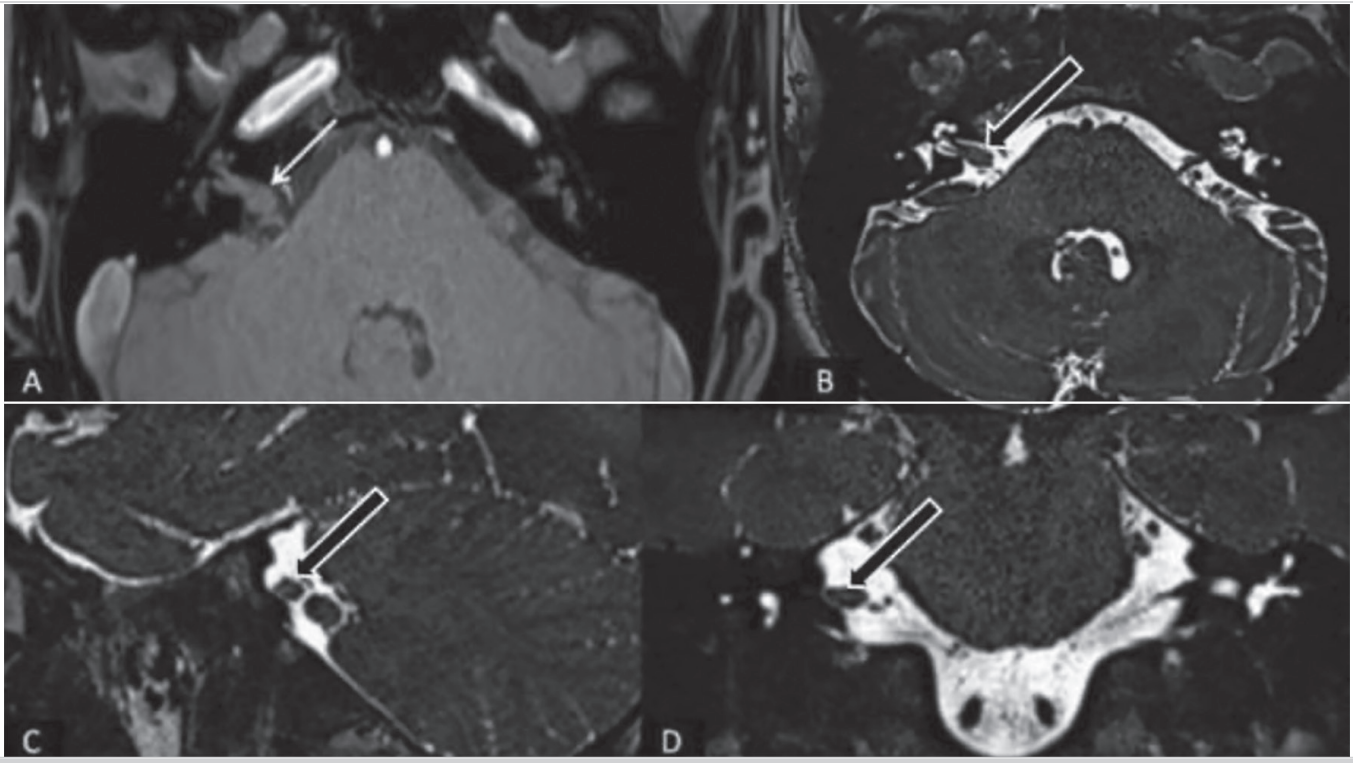

Figure 1. A 19-year-old patient with herniation of the cerebellar flocculus into the internal auditory canal. The axial T1-weighted MR image (A) shows a herniation of the cerebellar flocculus into the right internal auditory canal (white arrow). The herniated structure is isointense with the cerebellar parenchyma. The axial (B), sagittal (C) and coronal (D) T2-SPACE MR images show that the cerebellar flocculus extends into the right internal auditory canal, mimicking a mass lesion (thick arrows)
MR: Magnetic resonance

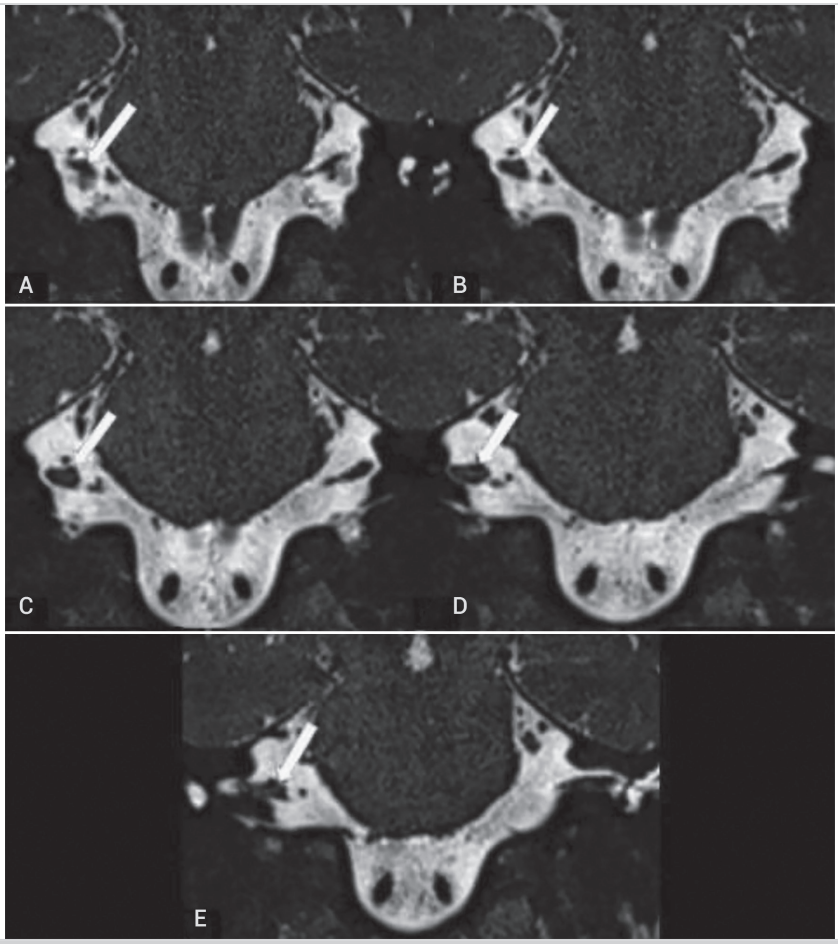

Figure 2. In consecutive coronal T2-SPACE MR images (A-E), the course of the cerebellar flocculus from the level of the pons to the entrance of the internal acoustic canal is observed (arrows)
MR: Magnetic resonance

the lateral aspect of the IAC, may exert a subtle mass effect or mechanical irritation on the adjacent vestibulocochlear nerve, particularly its cochlear portion. Even if there is no obvious compression on imaging, this altered anatomical relationship could lead to local ischemia, demyelination, or disruption of axonal transport within the nerve fibers, resulting in hearing loss (3,5). In addition, herniated cerebellar tissue may alter cerebrospinal fluid (CSF) dynamics within the IAC, resulting in increased pressure or turbulence that could disrupt neural signaling. These hypotheses are supported by case reports describing improvement of auditory symptoms after surgical decompression or spontaneous regression of the hernia (3-6).

In this study, a systematic literature search was done in the PubMed and Google Scholar databases, focusing on cases of herniation of the flocculus cerebellaris into the IAC. The literature identified four cases, including ours, of herniation of the flocculus cerebellaris into the IAC. The cases of herniation of the flocculus cerebellaris into the IAC are summarized in Table 1. Michiwaki et al. (4) documented a case series in which herniation of the flocculus was associated with sensorineural hearing loss, supporting the hypothesis that herniated cerebellar tissue may exert a subtle mass effect or alter CSF dynamics near the vestibulocochlear nerve, even without obvious compression on imaging. Their work emphasizes the theoretical clinical relevance of this rare anatomical variant and suggests a possible correlation with auditory symptoms in selected cases. In another report, Parlak et al. (7) described a flocculus hernia in a case of incomplete partition type I and suggested that congenital inner ear anomalies may favor a hernia due to altered subarachnoid architecture. Parlak et al. (7) emphasized the importance of high-resolution 3D T2W techniques for the reliable diagnosis of floccular herniation, especially for the differentiation of neoplasms of the IAC and cystic lesions. Their study highlights the non-progressive nature of this variant and emphasizes incidental detection. They also suggested a possible association with non-specific vestibulocochlear symptoms. Kowalski et al. (5) reported a pseudomass in a 73-year-old female with sensorineural hearing loss that was consistent with flocculus cerebellaris and extended into the

Table 1. Demographic, clinical, and radiologic findings of cases of herniation of the flocculus cerebellaris into the IAC in the literature

Case	Author/year	Age/gender	Etiology	Symptoms	MRI findings	Management
1	Michiwaki et al. 2018 (4)	50/F	Tentorial meningioma, hydrocephalus	Mild hearing loss	Flocculus in the right IAC	Tumor resection
2	Parlak et al. 2023 (7)	3/F	Inner ear anomaly	Congenital SNHL	Bilateral IP-I, flocculus in the right IAC	Conservative
3	Kowalski et al. 2024 (5)	73/F	Idiopathic	SNHL	Flocculus in the right IAC	Conservative
4	Presented case	19/M	Idiopathic	Vertigo, imbalance	Flocculus in the right IAC	Conservative

F: Female, M: Male, MRI: Magnetic resonance imaging, IAC: Internal auditory canal, SNHL: Sensorineural hearing loss, IP-I: Incomplete partition type I

right IAC. Bluher and Moody-Antonio (8) reported a case of brainstem herniation into a bulbous IAC, which involved a different structure but emphasizes the importance of abnormal CSF pressure dynamics and congenital canal dilatation in such cases. The authors pointed out that this finding may mimic vestibular schwannomas, especially on low-contrast imaging. Our idiopathic case in an adult patient gives us valuable information about the spectrum of this anatomic variant and supports the hypothesis that floccular protrusion can occur independently of a mass effect or congenital ear abnormalities. Recognition of this variant is important for radiologists and otolaryngologists.

On 3D T2W sequences, a floccular herniation typically appears as a smooth, tongue-shaped, non-enhancing structure with CSF signal intensity surrounding it and in continuity with the cerebellum (7-9). This is in contrast to enhancing lesions such as vestibular schwannomas or meningiomas, which often compress or displace adjacent nerves. Epidermoid cysts show diffusion restriction, and arachnoid cysts are CSF-isointense in all sequences and show no tissue continuity. While most cases are incidental and asymptomatic, in rare cases a flocculus hernia may cause vestibular symptoms due to its anatomical proximity to the vestibular nerve. However, direct causal relationships are difficult to establish. In our case, the symptoms were transient and resolved spontaneously, suggesting either an independent etiology or a mild transient vestibular disorder (6-9).

Conclusion

If a lesion in the IAC is smooth, has no contrast enhancement, is adjacent to the cerebellar tissue, and is surrounded by CSF, a flocculus hernia should be considered as the primary diagnosis rather than neoplastic or cystic lesions. Awareness of this benign variant by radiologists and ear nose and throat specialists may prevent unnecessary diagnostic examinations, interventions, and patient anxiety. This underappreciated entity reminds us that not every mass-like structure in the IAC is pathologic sometimes the anatomy simply takes an unusual course. We believe that the incidence of such cases will increase with the routine use of high-gradient MRI machines and high-resolution MRI sequences.

Ethics

Informed Consent: Informed consent was obtained from the patient.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.H.A., A.B., Concept: M.H.A., N.B., S.A., Design: M.H.A., N.B., S.A., Data Collection and/or Processing: M.H.A., Analysis or Interpretation: M.H.A., N.B., S.A., A.B., Literature Search: M.H.A., N.B., S.A., A.B., Writing: M.H.A., S.A., A.B.

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Main Points

- Herniation of the flocculus cerebellaris into the internal auditory canal is a rare anatomical variant.
- It can mimic a tumor but shows characteristic magnetic resonance imaging features without enhancement or nerve compression.
- Patients may exhibit vestibular or auditory symptoms or remain asymptomatic.
- Awareness of this variant helps to avoid misdiagnosis and unnecessary treatment.

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