Original Research

Frequency and Clinical Significance of Incidental Findings Detected in Internal Acoustic Canal Magnetic Resonance Imaging of Patients with Audiovestibular Symptoms

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Abstract

Objectives: Retrocochlear pathology associated with audiovestibular symptoms is detected in very few of the patients, and most of the internal acoustic canal magnetic resonance imaging examinations (IAC-MRIs) are either completely normal or include accompanying incidental findings (IFs). The aim of our study is to reveal the presence and frequency of IFs in IAC-MRIs, together with retrocochlear lesions. In addition, we intend to emphasize the clinical importance of these IFs.

Methods: A retrospective analysis of 374 serial IAC-MRI scans.

Results: Gender distribution: 201 males and 173 females. Age range: 2–82 years. Seventy-two scans (19.25%) were totally normal. Fifteen scans (4.01%) demonstrated only pontocerebellar angle findings (PCAFs). The presence of PCAF and IF was together in 57 scans (15.24%). In 230 (61.50%) of the scans, only IFs were present. The incidence of IFs in all IAC-MRIs was 76.74% (287 of 374). Critical findings that may require clinical further evaluation and examination were present in 34 scans (9.09%). IFs that did not require further examination were observed in 253 scans (67.65%).

Conclusion: Various IFs can be detected with IAC-MRI that may cause similar symptoms with PCAF. And unfortunately, some of these IFs may be of very high clinical importance. All referral clinicians should know well that these audiovestibular symptoms can appear as IFs anywhere in the auditory pathway, and how they should be followed in their clinical approach.

Keywords: Auditory diseases, central; auditory pathways, incidental findings, magnetic resonance imaging, neurotology.

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Tinnitus, sudden sensorineural hearing loss (SSNHL), and vertigo are common audiovestibular symptoms. In patients with these symptoms, radiological imaging may be needed.[1] In radiological imaging, the presence of a retroco-chlear lesion in the internal acoustic canal (IAC) and ponto-cerebellar angle (PCA) is investigated. Magnetic resonance imaging (MRI) is preferred because of its cost effectivity, accuracy, and superiority compared to other imaging meth-

ods.[2-5] The most common tumoral pathology encountered in PCA is acoustic neuroma.[5] Since the symptoms seen in PCA pathologies are general audiovestibular symptoms, they can be easily overlooked. This has increased the frequency of MRI.[6] However, retrocochlear pathology associated with symptoms is detected in very few of these patients, and most of the MRIs are either completely normal or include accompanying incidental findings. Incidental finding (IF) is defined as "asymptomatic findings that are incidentally detected and have potential clinical significance, which are not related to the purpose of imaging and may cause symptoms that require treatment".[1] In the literature, there are studies investigating IFs in cranial MRIs in various patient groups, and white matter hyperintensities (WMH), signal changes associated with mastoiditis and rhinosinusitis, vascular loop, intracranial masses, vascular anomalies, and empty sella have been reported as the most common IFs.[1,2,7,8] However, specific guidelines for these IFs showing how to approach or deal with are not sufficient.[9]

The aim of our study is to reveal the presence and frequency of IFs in IAC-MRIs of patients with audiovestibular symptoms, together with retrocochlear lesions, which are the primary purpose of the examination. In addition, we intend to emphasize the clinical importance of these IFs and to discuss the clinical approach, especially in incidental lesions that require further evaluation, in the light of literature.

Methods

Before this study, the local Ethics Committee approval was obtained (decision number: 2018-2; date: January 24, 2018). IAC-MRI examinations carried out in our radiology department between 2015 and 2017, with audiovestibular symptoms such as SSNHL, vertigo, unilateral tinnitus, and suspicion of PCA pathology were retrospectively evaluated through Workstation (General Electric, Advantage Workstation, 4.4 edition). Eight patients who were previously diagnosed with acoustic neuroma and had MRI imaging for follow-up purposes, four patients who were previously followed up due to a history of malignancy, and one patient with a history of trauma and temporal bone fracture 11 days before the MRI examination (total 13 cases) were excluded from the study. The age, gender, complaints, pre-diagnoses, and clinical information of the patients were obtained from the patient registry information. The MRI images of 374 cases included in the study were examined retrospectively by a radiology assistant with 4 years' experience and a head-and-neck radiologist with 10 years' experience based on consensus. Diagnoses were made based on MRI characteristics of the findings. The cases were categorized as those with only PCA pathology, those with IF only,

those with both PCA pathology and IF, and those without PCA pathology or IF. All PCA pathologies and IFs detected by MRI were listed. IFs that require advanced clinical evaluation, follow-up, or treatment (e.g., cerebral aneurysm, intracranial, or head-neck mass) were defined as "clinically significant," whereas those that do not require follow-up or treatment (e.g., paranasal sinus signal changes and mega cisterna magna) were defined as "clinically not significant."

Imaging Technique

MRI examinations of the cases were performed with a 1.5 Tesla MRI scanner (GE Signa, HDxt; GE Healthcare, WI, USA). The MRI protocol was identical for all cases and included coronal T2 turbo spin echo (TR/TE, 5440/85 msn; matrix, 416 × 256; slice thickness, 3 mm); axial T2 turbo spin echo (TR/TE, 4440/85 ms; matrix, 320 × 224; slice thickness, 3 mm); axial 3D fiesta (TR/TE, 4.84/1.90 ms; matrix, 330 × 256; slice thickness, 1 mm); axial 3D T1 fat saturated (TR/TE, 4.80/1.67 ms; matrix, 224 × 224; slice thickness, 1 mm); coronal 3D T1 fat saturated (TR/TE, 10.02/4.20 ms; matrix, 320 × 192; slice thickness, 1.6 mm); and following contrast media injection, coronal 3D T1 fat saturated (TR/TE, 10.02/4.20 ms; matrix, 320 × 192; slice thickness, 1.6 mm) and axial 3D T1 fat saturated (TR/TE, 4.80/1.67 ms; matrix, 224 × 224; slice thickness, 1 mm) sequences.

Statistical Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences version 20.0 software. All data of both PCA pathologies and IFs were given as frequency and ratio. Chi-square test was used for analysis of categorical variables and t-test was used for analysis of continuous data. Statistical significance limit was accepted as $p=0.05$.

Results

The mean age of 374 patients (201 males and 173 females) included in the study was 54.9±17.0 years (range, 2–85). The reasons for presentation of the cases were unilateral tinnitus (29.7%), SSNHL (38.7%), vertigo (19.2%), facial asymmetry (2.5%), and other reasons (ear pain and ear fullness) (9.9%).

No abnormal findings were detected in 72 (19.25%) of 374 IAC-MRIs and they were reported as completely normal. Fifteen examinations (4.01%) had findings related only to PCAF such as acoustic neuroma, vestibular neuritis/Bell's palsy, and vascular loop, and there was no other accompanying IF. The presence of PCAF and IF was together in 57 cases (15.24%). In 230 (61.50%) of the cases, only IFs were present. The incidence of IFs in all cases was 76.74% (287 of 374). Among IFs, critical findings that may require clinical further evaluation and examination were present in 34 cas-

es (9.09%), while IFs that did not require further examination were observed in 253 cases (67.65%) (Tables 1 and 2).

The mean age of the patients with IFs (56.8±16.4) was significantly higher than that of the patients without IFs (48.0±17.5) (p<0.001).

PCAF

As PCAF, 5 (1.34%) of our cases had acoustic neuroma, 11 (2.94%) had vestibular neuritis/Bell's palsy, and 57 (15.24%) had a vascular loop (Fig. 1). How many of these lesions were seen alone, how many were seen with other PCAF and IFs, what were the accompanying IFs, and how these IFs were approached are summarized in Table 1.

Of the vascular loop cases in our study, 13 were bilateral and 44 were unilateral (24 right and 20 left). Of these cases, 21 patients had tinnitus, 18 had SNHL, 14 had vertigo, 1 had peripheral facial paralysis, 1 had both tinnitus and vertigo, 1 had SNHL with vertigo and tinnitus, and 1 had SNHL and peripheral facial paralysis. Vascular loop observation was

significantly higher in patients presenting with tinnitus (22.8%) compared to patients presenting with other complaints (p=0.024).

IF

The most common IF was neural parenchymal WMH and it was present in 117 (31.28%) of the cases (Fig. 2). The age distribution of the cases with WMH varied between 30 and 85 (median 62). Cerebral atrophy findings were detected in 77 cases (20.59%). There was a significant correlation between age and WMH (p<0.001), and between age and atrophy (p<0.001). As age increased, both WMH and atrophy increased.

Paranasal sinus and mastoid/tympanic cavity findings, which were mostly observed as mucosal thickening and signal increases indicating effusion/inflammation, were detected in 87 (23.26%) and 81 (21.66%) cases, respectively (Fig. 3). Sixty-three cases (16.84%) who had nasopharynx posterior wall thickening on MRI were referred to the oto-

Table 1. MRI findings

MRI findings	No. (%)	Management/result*
Normal	72 (19.25)	NFA
Only PCAF	15 (4.01)	
Acoustic neuroma	1 (0.27)	
Vestibular neuritis/Bell's palsy	5 (1.34)	
Vascular loop	9 (2.41)	
PCAF+IF	57 (15.24)	
PCAF+IF (clinically significant)	12 (3.21)	
Acoustic neuroma+pineal nodule	1 (0.27)	NRS/follow-up
Vestibular neuritis/Bell's palsy+vascular loop+nasopharyngeal soft-tissue thickening	1 (0.27)	ORL/lymphoid hyperplasia
Vestibular neuritis/Bell's palsy+partial empty sella	2 (0.53)	NRL/follow-up
Vascular loop+parotid mass	1 (0.27)	ORL/pleomorphic adenoma
Vascular loop+lingual mass	1 (0.27)	ORL/hemangioma
Vascular loop+mandibular mass	1 (0.27)	ORL/multiple myeloma
Vascular loop+ICA wall irregularity	1 (0.27)	NRL/MRA recommended
Vascular loop+vertebral artery agenesis/thrombosis	1 (0.27)	NRL/MRA recommended
Vascular loop+frontal lobe signal	1 (0.27)	NRS/follow-up
Vascular loop+meningioma	1 (0.27)	NRS/follow-up
Vascular loop+brachium pontis hyperintensity and enhancement	1 (0.27)	NRS/follow-up
PCAF+IF (clinically not significant)	45 (12.03)	
Acoustic nuroma+IF	3 (0.80)	NFA
Vestibular neuritis/Bell's palsy+IF	3 (0.80)	NFA
Vascular loop+IF	39 (10.43)	NFA
Only IF	230 (61.50)	
IF (Clinically significant+not significant)	22 (5.88)	RAD
IF (Clinically not significant)	208 (55.61)	NFA
Total	374	

PCAF: Pontocerebellar angle finding; IF: Incidental finding; NFA: No further action; ORL: Otorhinolaryngology; NRS: Neurochirurgie; NRL: Neurology; MRA: Magnetic resonance angiography; RAD: Referral to appropriate departments, *management/result information is based on incidental findings only.

Table 2. Incidental MRI findings

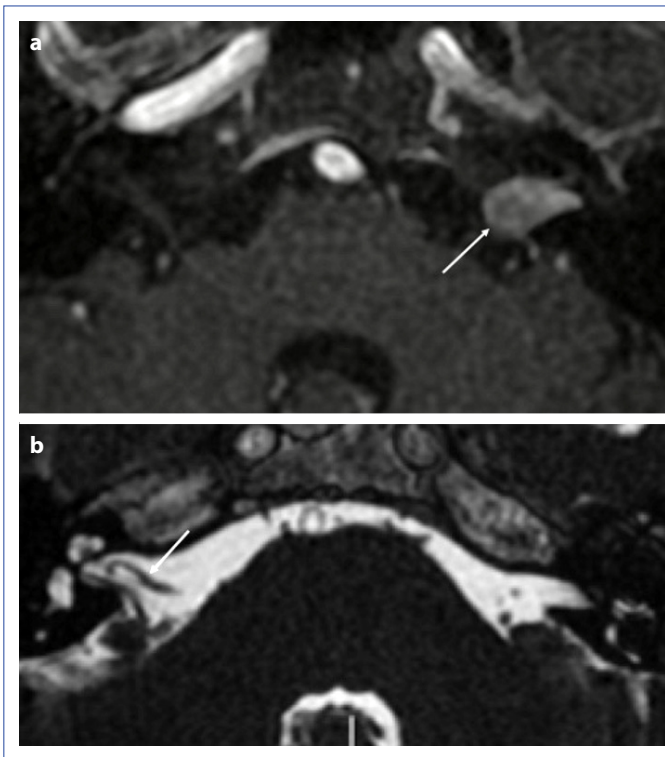| Incidental findings	No. (%)	Management
White matter hyperintensities	117 (31.28)	
SVD	37 (9.89)	NFA
Non-SVD	80 (21.39)	NRL
Paranasal sinus findings	87 (23.26)	NFA
Tympanic cavity/mastoid signals	81 (21.66)	
Tympanic/mastoid signals only	78 (20.86)	NFA
Tympanic/mastoid signals with nasopharyngeal wall thickening	3 (0.80)	ORL
Cerebral atrophy	77 (20.59)	NFA
Nasopharynx soft-tissue thickening	63 (16.84)	ORL
Vascular anomalies and pathologies	36 (9.63)	
Hypoplasia/agenesis	20 (5.35)	
Vertebral artery hypoplasia	15 (4.01)	NRL
ACA hypoplasia/agenesis	5 (1.34)	NFA
Aneurysm	8 (2.14)	
MCA	6 (1.60)	NRS
Basilar artery	2 (0.53)	NRS
Stenosis/occlusion	4 (1.07)	
ICA occlusion	2 (0.53)	NRL
Vertebral artery occlusion	1 (0.27)	NRL
Basilar artery stenosis	1 (0.27)	NRL
Dural sinus thrombosis	1 (0.27)	NRL
DVA	2 (0.53)	NFA
Fetal posterior cerebral artery	1 (0.27)	NFA
Thin intraocular lens	18 (4.81)	NFA
Empty/partial empty sella	17 (4.55)	
Empty/partial empty sella only	13 (3.48)	NFA
+Perioptic CSF enlargement	4 (1.07)	NRL + OPH
Intracranial mass/suspect mass	7 (1.87)	
Intra-axial	2 (0.53)	NRS
Extra-axial (meningioma)	1 (0.27)	NRS
Pituitary microadenoma	3 (0.80)	NRS
Pituitary macroadenoma	1 (0.27)	NRS
Arachnoid Cyst	6 (1.60)	NFA
Perioptic CSF Enlargement	6 (1.60)	
Perioptic CSF enlargement only	2 (0.53)	NFA
+Empty/partial empty sella	4 (1.07)	NRL+OPH
Hydrocephalus	5 (1.34)	NRL + NRS
Mega cisterna magna	3 (0.80)	NFA
Glomus jugulare	2 (0.53)	ORL
Suspect inner ear malformation	1 (0.27)	ORL
Parotid mass	1 (0.27)	ORL
Encephalomalacia	1 (0.27)	NFA
Optic neuritis	1 (0.27)	NRL

SVD: Small vessel disease; ACA: Anterior cerebral artery; MCA: Middle cerebral artery; ICA: Internal carotid artery; DVA: Developmental venous anomaly; NFA: No further action; ORL: Otorhinolaryngology; NRS: Neurochirurgie; NRL: Neurology; OPH: Ophthalmology.

rhinolaryngology department for clinical examination. Among these, three cases with associated mastoid/tympanic cavity signal increase and one case with focal soft-tissue thickening in the nasopharynx and vascular loop in PCA were diagnosed with lymphoid hyperplasia by naso-
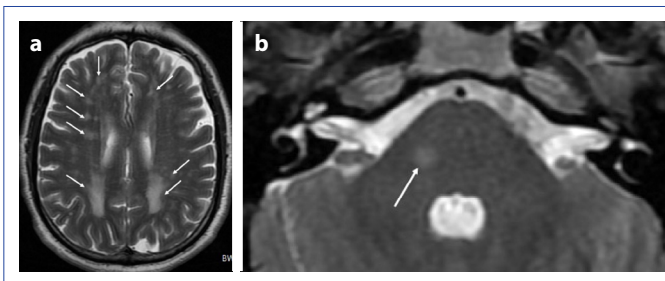
pharynx biopsy. Biopsy was not required in the otorhino-laryngologic examination of the other cases.

Another remarkable group among IFs was findings suggestive of an intracranial mass. There were 7 (1.87%) cases in this group. One (0.27%) had meningioma, 1 (0.27%) had
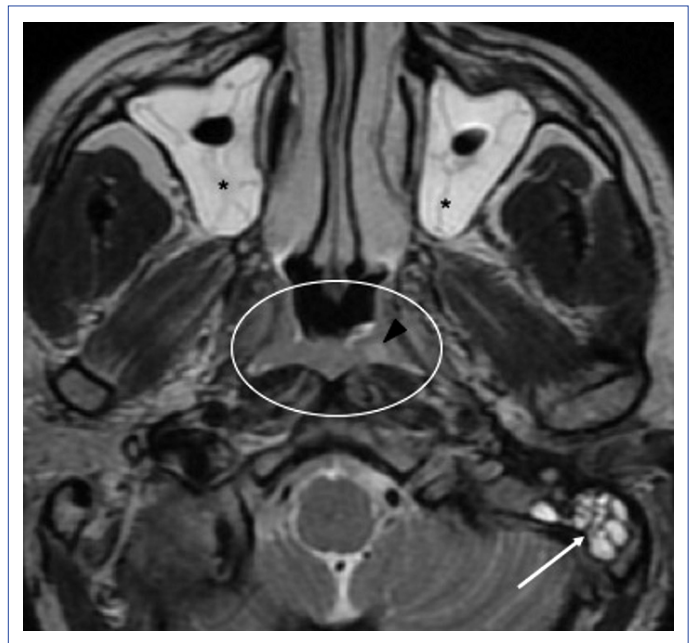
Figure 1. Axial contrast-enhanced T1-weighted image of a 58-year-old female patient. In the left internal acoustic canal, heterogeneous intense enhancing acoustic neuroma is seen (arrow) **(a)**. Axial FIESTA image of a 39-year-old male patient. On the right, there is a vascular loop extending into the acoustic canal (arrow) **(b)**.
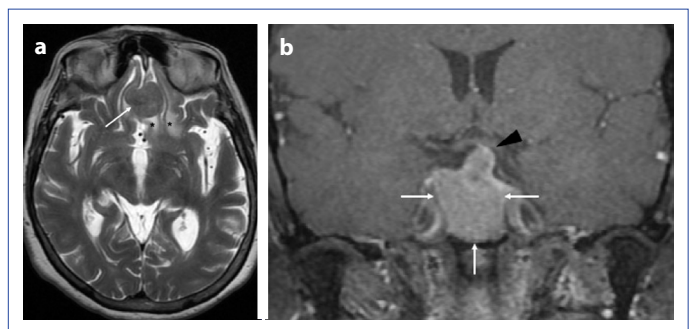

Figure 2. Axial T2-weighted image of a 57-year-old male patient. Numerous widespread white matter hyperintensities are observed in the neural parenchyma at the centrum semi-ovale level (arrows) **(a)**. Axial T2-weighted image of a 14-year-old female. On the right side of the pons, there is a faint hyperintensity (arrow) **(b)**.

pituitary macroadenoma, and 3 (0.80%) had pituitary microadenoma findings (Fig. 4). In 2 cases (0.53%), one in the frontal lobe and the other in the brachium pontis, suspect parenchymal focal signal increase was observed suggesting a mass. These cases were referred to neurosurgery and/or endocrinology departments for further evaluation.

Incidental vascular pathologies were also among the most common findings in our study, and there were 36 cases

Figure 3. Axial T2-weighted image of a 39-year-old male. Hyperintensities reflecting effusion/inflammation are observed in both maxillary sinus (asterix) and mastoid cells on the left (arrow). In addition, the left pharyngeal mucosal weak hyperintensity (arrowhead) is observed in the posterior wall of the nasopharynx accompanied by diffuse soft-tissue thickening (circle).
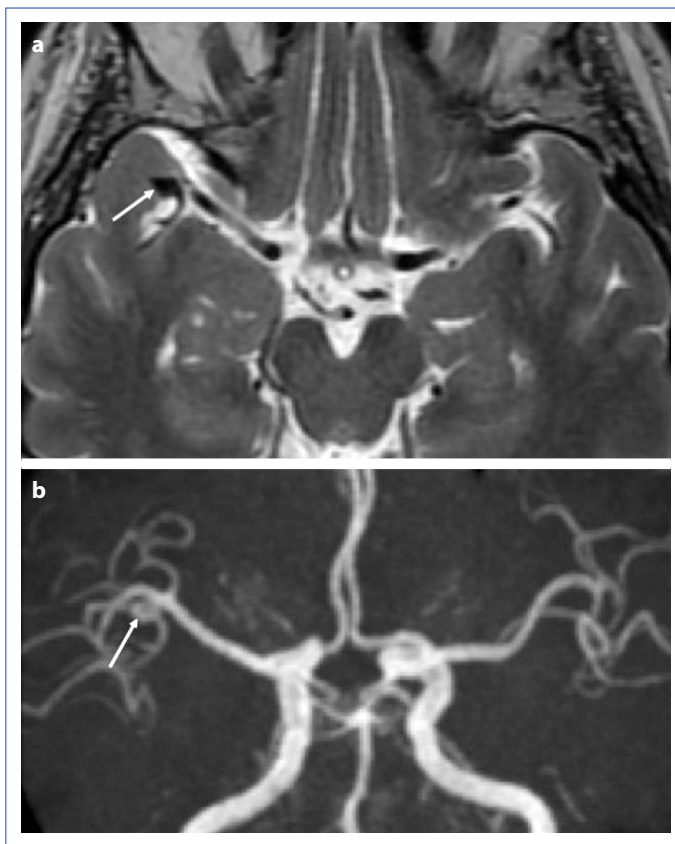

Figure 4. Axial T2-weighted image of a 70-year-old female. In the frontobasal region, there is a lobulated extra-axial midline mass (arrow) with similar intensity to the neural parenchyma, and there is mild hyperintensity around it, indicating edema (asterix) **(a)**. Coronal contrast-enhanced image of a 44-year-old male. There is an intensely enhancing mass obliterating the sellar cavity and suprasellar cisterna (arrow), and compressing the optic chiasm (arrowhead) **(b)**.

(9.63%). Of these, 15 (4.01%) were reported as vertebral artery hypoplasia, 8 (2.14%) as aneurysm or aneurysm suspicion, and 5 (1.34%) as anterior cerebral artery (ACA) A1 segment hypoplasia. In cases with vertebral artery hypoplasia, color Doppler ultrasonography was recommended in the presence of clinical findings that may be related to vertebrobasilar insufficiency and the cases were referred to the neurology department. One case with a giant thrombosed

aneurysm in the basilar artery was referred to the neurosurgery department for further examination and treatment. In seven cases with suspected aneurysm, magnetic resonance angiography (MRA) was recommended for confirmation and no apparent aneurysm was observed in five of them. One case was referred to interventional radiology for digital subtraction angiography examination and treatment, on the detection of a saccular aneurysm of the right middle cerebral artery with a diameter of 6 mm in MRA examination (Fig. 5). For the remaining one case, there was no control or follow-up radiological examination in the database. Cases reported radiologically as suspect internal carotid artery, vertebral artery and basilar artery stenosis/occlusion (four cases), and dural sinus thrombosis (one case) were referred to the relevant clinics and MRA and MR venography were recommended, respectively. Developmental venous anomaly (DVA) in two of our cases and a variant fetal posterior cerebral artery in one case were also observed.

There were 17 (4.55%) cases with empty/partial empty sella, 6 (1.60%) cases with increased perioptic cerebrospinal fluid (CSF) space, and 5 (1.34%) cases with hydrocephalus. Four cases (1.07%), in which an increase in the perioptic

CSF space was observed together with the empty/partial empty sella, were referred to neurology and ophthalmology departments for further evaluation with suspicion of idiopathic intracranial hypertension. No obstructive mass was observed in MRI of hydrocephalus cases and they were referred to the neurology and neurosurgery departments for further clinical evaluation with suspicion of aqueduct stenosis/normal pressure hydrocephalus, and CSF flow MRI was recommended if necessary.

In 2 cases (0.53%) with unilateral tinnitus in one and unilateral partial hearing loss in the other, we detected glomus jugulare on MRI (Fig. 6). They were referred to the neurosurgery department and Gamma Knife radiosurgery was planned.

There was no significant relationship between IFs and audiovestibular symptoms of the patients.

Discussion

MRI is superior to examination methods such as auditory brain stem response in terms of cost-effectiveness and accuracy.[2,10] Intravenous contrast-enhanced MRI is the imaging method of choice in patients with audiovestibular symptoms, and it has been accepted as the gold standard in the detection of PCA pathologies such as acoustic neuroma, Bell's palsy/vestibular neuritis, and vascular loop.[1,2,4,5,10-12] In our study, the detection rate of these PCA pathologies was as follows: Acoustic neuroma in 5 cases (1.34%), Bell's palsy/vestibular neuritis in 11 cases (2.94%), and vascular loop in 57 (%15.24) cases.

The vascular loop is a component of anterior inferior cerebellar artery (AICA) that progresses close to the 7th and 8th nerves at the PCA or IAC level.[1,8] It can be detected up to approximately 33% of the population.[2] There are many publications stating that the vascular loop can cause au-

Figure 5. Axial T2-weighted image of a 56-year-old female. There is a hypointense vascular nodule in the right MCA bifurcation, suggesting aneurysm **(a)**. Magnetic resonance angiography of the same patient **(b)**.

Figure 6. Axial contrast-enhanced image of a 45-year-old male. There is an intensely enhancing mass that is located in the right jugular fossa (arrows).

diovestibular symptoms.[1,13-17] In our study, vascular loop finding was significantly higher in patients presenting with tinnitus than patients presenting with other complaints (p=0.024). Due to the correlation between audiovestibular symptoms, especially tinnitus, and vascular loop findings, and the vascular loop is frequently observed in PCA and IAC, we listed the vascular loop in PCAF in our study. We observed that in almost all cases with vascular loop, medical treatment was arranged according to the related symptoms.

In this retrospective study, the IF rate found in 76.74% of our cases was higher than the IF rates between 41.9% and 50.5% found in similar studies.[1,2,8,10] We think that this may be due to the fact that we have listed the IFs in greater detail. Because it is seen that IFs, which we found in high numbers in our study, such as nasopharynx posterior wall thickening, empty/partial empty sella, and vertebral artery hypoplasia, were not taken into account in the study samples in the literature. Another reason may be the axial and coronal T2W images we obtained for almost the entire neural parenchyma besides the standard images in IAC-MRI. It is predicted that MRI images and new sequences that will be obtained with higher magnetic field strength and high resolution will be more sensitive in detecting structural changes and the rate of findings to be detected will increase.[3]

The most common IF in our study is WMH with a rate of 31.28%, which is similar to many studies.[1,2,8,10] Cerebral atrophy was also among the IFs we frequently see, and it was present in 20.59% of our cases. Considering the literature data, incidental cerebral atrophy rates vary between 3.2% and 5.5%.[1,8,10] Various studies have reported that both WMH and cerebral atrophy increase with age.[1] In our study, a significant correlation was observed between age and both WMH and cerebral atrophy (p<0.001). Although the exact cause of WMH has not yet been established, it is thought that they are mostly of ischemic origin.[1] The differential diagnosis of these lesions is broad and includes primary and secondary central nervous system vasculitis, demyelinating processes such as multiple sclerosis (MS), migraine, and genetically inherited lesions such as CADASIL and MELAS.[1,18] Studies have reported that demyelinating diseases may have characteristic MRI findings.[8] However, it has been emphasized that non-specific WMH can be observed in early MS, and intense signal changes can be observed in advanced MS disease with a high lesion load, which can be confused with chronic microvascular ischemia.[18] In our study, there were no characteristic MRI findings indicative of demyelinating process, especially MS, in any of the patients with WMH. However, among our patients, especially those in the young-middle age group

with WMH and who did not have a predisposing factor for small vessel disease were referred to the neurology department for possible early demyelinating process, vasculitis, and/or migraine.

It has been stated that ischemic lesions of the brainstem can also lead to audiovestibular symptoms such as tinnitus.[4,19] In our study, 35 (9.36%) of our cases with WMH also had hyperintense foci in the pons or medulla oblongata. The reason for the high number of cases with cerebral WMH and cerebral atrophy in our study may be the high number of elderly population in our case group. In addition, it is known that WMH and central atrophy may cause auditory central processing impairment and consequently a decrease in speech discrimination score.[20] Abnormal decline in speech discrimination is one of the reasons clinicians request tests to investigate retrocochlear pathology. Here, retrocochlear pathology includes not only PCA pathologies but also central pathologies. Naturally, these cases will have higher central processing impairment, hence, central atrophy and hyperintensity rates in MRI imaging compared to the normal population. This may be another reason for our high cases of WMH and central atrophy. However, since white matter and brainstem hyperintensities and signs of atrophy may accompany many neuro-otological conditions, we think that it is important for clinicians, especially otorhinolaryngologists, to know that the specificity of these lesions is low and should be evaluated according to the patient's clinical condition.

In our study, incidental paranasal sinus findings were detected in 23.26% of our cases. Studies have shown that sinus findings are quite common in MRI examinations performed for reasons other than sinonasal complaints.[1] In the literature, paranasal sinus IF rates detected on MRI are reported between 6% and 85.2%.[1,21] These findings have been observed ranging from simple mucosal thickening to pansinusitis.[8] In some studies, it has been stated that incidental paranasal sinus MRI findings are not associated with symptoms or are very poorly related.[22,23] Nazri et al.,[21] on the contrary, showed that there is a significant correlation between the incidental paranasal sinus findings seen in MRI and the symptoms of the patients. The current approach in this regard is that when evaluating paranasal sinus MRI findings, it should be clinically correlated.[1] In our study, no significant relationship was found between paranasal sinus findings and patients' symptoms.

In our study, incidental signal changes were detected in the middle ear and mastoid cells in 21.66% of the cases. In the literature, the rates of these signal changes reflecting inflammation/effusion in middle ear and mastoid cells vary between 3% and 25%, and most studies have not revealed

the cause of these signal increases and their relationship with audiovestibular symptoms. In very few studies, however, a relationship between increased mastoid/tympanic signal and audiovestibular symptoms has been shown clinically.[1,8] In our study, it was observed that none of the patients with increased T2 signal in the mastoid/tympanic cavity had any complaints or clinical findings associated with audiovestibular symptoms.

Intracranial mass lesions detected incidentally by MRI have been the subject of many studies in the literature. In these studies, the incidence of benign masses has been reported between 1.6% and 9.2%, and the incidence of neoplasms between 0.1% and 0.7%. It has been stated that the most common benign lesions are meningiomas with 2.5%.[3,9] In our study, there were a total of 7 (1.87%) cases with MRI findings suggesting an intracranial mass. While 1 (0.27%) of them was meningioma, 4 (1.07%) were pituitary adenoma, 2 (0.53%) were in the form of signal changes that caused suspicion of intraparenchymal mass. In particular, our rate of meningioma detection was much lower than some studies in the literature. In our study, although axial and coronal T2 sequences were obtained for the whole neural parenchyma, contrast-enhanced series were obtained only for IAC and PCA. Therefore, it is possible that some intracranial pathologies, especially meningioma, whose T1 and T2 signals do not differ significantly from normal parenchyma, may be detected less than they actually are.

In our study, 36 cases (9.63%) had MRI findings compatible with incidental vascular anomaly and pathology. This rate was similar to the rates reported in the literature.[1,8,10] Among these, vertebral artery hypoplasia was the most common, with 4.01%. Vertebral artery hypoplasia has been defined as a vertebral artery diameter of ≤2 mm, ≤2.2 mm, and ≤2.5 mm by radiological examination methods in different studies, and its incidence has been reported between 1.9% and 26.5%.[24] In our study, the vertebral artery V4 segment was evaluated as hypoplastic if it was observed with a diameter of ≤2 mm and preserved the luminal signal void flow pattern. In case of stenosis in any part of the intracranial arteries and dural venous sinuses and/or loss of luminal signal void flow pattern, advanced clinical and radiological evaluation was recommended to exclude stenosis/occlusion.

Incidental MRI findings that might indicate aneurysm were present in 8 of our cases (2.14%). In a recent large study including 5800 cases, the incidental aneurysm rate detected on MRI was reported as 2.3%.[9] However, in our study, the appearance in seven cases except for one case with a giant thrombosed basilar artery aneurysm were in the form of suspicion of aneurysm, and aneurysm could not be confirmed with MRA in five of them. In these cases, it was observed that the appearance that caused aneurysm suspicion was primarily due to technical details, especially the slice thickness, in the IAC-MRI examination, which is not intended for vascular imaging. Although the number of cases reported as aneurysm suspicion did not give the true aneurysm rate incidentally, considering the serious clinical consequences of a possible aneurysm, we think that even the smallest aneurysm suspicion should be stated and an additional unenhanced cranial MRA should be used to reduce this risk.

Other vascular anomalies we found in our study were ACA-A1 segment hypoplasia, fetal posterior cerebral artery, and DVA. ACA-A1 segment hypoplasia and fetal posterior cerebral artery are anomalies that are not very rare in the population and do not cause any symptoms or negative clinical consequences unless there is an accompanying thromboembolic event.[25,26] DVA is one of the findings that are usually detected coincidentally and is considered benign.[27] We specified these vascular lesions in the routine radiological report and no additional recommendation was made.

In our study, the rate of detection of IFs among all cases was 76.74%, and the rate of patients who were clinically important and referred to the relevant specialist for further examination, follow-up, and treatment was 9.09% (34 out of 374). There are many studies in the literature stating that IF rather than PCAF can be seen frequently in cranial MRI examinations.[1,8] Katzman et al.,[7] in their study with a large group of healthy volunteers, reported all IFs as 18% and clinically significant IFs as 1.1%. Mirza et al.[8] and Papanikolau et al.,[1] in two separate studies in which they evaluated MRI examinations performed with suspicion of PCA tumor, reported an IF rate of 41% and 47.5%, respectively. In the latter, it was stated that 2.5% of these cases were referred to the relevant specialist due to the clinical importance of IFs. On the other hand, Choi et al.[4] reported a clinically insignificant IF rate as 90.8% in their study.

The main limitations of our study are the fact that almost all IF diagnoses we detected were based on MRI imaging features, and the follow-up data of some cases for whom clinical follow-up and advanced radiological examination were recommended in radiological reporting were not available. Although there are no pathological data of IFs in most of our cases, most of the IFs encountered in IAC-MRI imaging consist of findings that do not require further examination and treatment. Since audiovestibular symptoms are not specific to IAC and PCA pathologies, it is possible that the probability of detecting PCAF is low and IF detection is high in most cases imaged with these symptoms. Therefore, we think that our study and future studies to be made

with larger series can be informative about the frequency and importance of IFs to be determined and the need for further follow-up. In addition, we believe that future studies should be designed to reveal the natural course of IFs, which is followed up but do not require treatment and interventional procedures.

Conclusion

Audiovestibular symptoms such as tinnitus, dizziness, and hearing loss cause IAC-MRI examination indication for detecting IAC and PCA tumors. Although the PCA tumor detection rate is not high in these examinations, many IFs can be detected that may cause similar symptoms or are not associated with symptoms. Most of these IFs, which have a high sensitivity to be detected with MRI and have a higher detection rate than expected, do not require further examination, follow-up, or treatment, but some of them are of very high clinical importance and can even be life threatening if ignored or overlooked. All clinicians, especially otorhinolaryngologists, who request MRI from their patients due to their audiovestibular symptoms, should know well that these symptoms can appear as IFs anywhere in the auditory pathway from the inner ear to the processing centers in the brain, and how they should be followed in their clinical approach. Whether it has clinical significance or not, these IFs must be reported by the radiologist, informing the patient about potential serious findings other than routine radiological reporting and referring to the relevant specialist physician.

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Disclosures

Ethics Committee Approval: Before this study, the local Ethics Committee approval was obtained (decision number: 2018-2; date: January 24, 2018).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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