MRI in Meniere's Disease

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Diagnostic Challenge

- Probable vs Definite
- MD can be difficult to diagnose clinically, especially when the symptoms are unusual, such as isolated fluctuating hearing loss (cochlear MD)

Application

- Japan Society for Equilibrium Research criteria
  - included the findings of MRI
  - Categories:
    - Certain
      - Presence of EH is mandatory
    - Definite
    - Probable

- Nakashima, et al., 2007: 3D-FLAIR MRI after IT Gd
- Pyykkö et al. 2013: Delayed 3-D-FLAIR MRI 4 hr after IV Gd
  - EH in 93% of the symptomatic MD patients
  - All definite cases

Evidence of application

- CH has a significant relationship with an abnormal auditory threshold in PTA and ECoG (Seo, et al., 2013).
- Grade of EH and the endolymphatic space dilation were significantly related to the level of hearing loss
- CH and/or VH were detected in 55–90% of patients with unilateral vertigo, tinnitus, or hearing loss in the symptomatic ear

Correlation of semi-quantitative findings of endolymphatic hydrops in MRI with the audiometric findings in patients with Meniere's disease

- Kazemi, et al
- Amir-alam Hospital
- Journal of Otology
- 2022, accepted for publication

Methods

The MD group included 19 patients

- recently diagnosed (within 2 weeks) with definite MD
- 14 unilateral and 5 bilateral
- total of 24 ears with definite MD

The control group consisted of 29 unaffected ear with sudden sensorineural hearing loss (SSNHL)

- 5 ears of the patients with unilateral schwannoma
- 24 ears of unilateral SSNHL patients

Radiologists identified the grade of

- vestibular hydrops (VH),
- cochlear hydrops (CH),
- vestibular aqueduct non-visibility (VANV),
- visually increased perilymphatic enhancement (VIPE)

VH Classification

- G0
  - no evidence of hydrops
- G1
  - saccule was equal to or larger than the utricle but with clear separation of both structures
- G2
  - saccule and utricle were no longer distinguishable from one another but still surrounded by an enhancing perilymph rim
- G3
  - surrounding enhancing perilymph rim was interrupted.

CH (Barath Classification)

- G0
  - no hydrops in the cochlea
- G1
  - only irregular or nodular dilatation was seen at the periphery of the scala vestibuli caused by the enlargement of the scala media and the displacement of Reissner’s membrane
- G2
  - cochlear duct or scala media entirely occupied the scala vestibuli

VANV Classification

- G0
  - VA was completely visible
- G1
  - VA was partially visible
- G2
  - VA was completely invisible

VIPE Classification

- Determined visually as positive or negative for each ear based on the judgment of radiologists.

Results

Control group

Control group

- 4 ears (13.7%) with VH grade 1
- 7 (24.1%) cases of CH grade 1

among the non-symptomatic ears of the unilateral MD patients (n = 14)

- 1 ear with VH grade 1 (7.1%)
- 1 with CH grade 1 (7.1%)

Temporal bone histopathology studies have also reported a 14% risk of bilateral progression in MD patients (House, et al., 2006)

Results –

Control group

None of the ears in the control group demonstrated VH or CH grade 2 or above

Only one instance of VANV grade 2 in an asymptomatic ear of a unilateral MD patient

All cases of VH or CH grade 2 or higher were among definite MD patients

	Ears with definite MD (n=24)		Asymptomatic ears of MD patients (n=14)		Ears of the control group (n=29)		Between-group (definite MD-control) comparison (sig.)
Grade of VH	G0	0 (0%)	G0	13 (92.9%)	G0	25 (86.3%)	<0.001
	G1	7 (29.2%)	G1	1 (7.1%)	G1	4 (13.7%)	
	G2	13 (54.2%)	G2	0 (0%)	G2	0 (0%)	
	G3	4 (16.7%)	G3	0 (0%)	G3	0 (0%)	
Grade of CH	G0	5 (20.8%)	G0	13 (92.9%)	G0	22 (75.9%)	<0.001
	G1	11 (45.8%)	G1	1 (7.1%)	G1	7 (24.1%)	
	G2	8 (33.3%)	G2	0 (0%)	G2	0 (0%)	
Grade of VANV	G0	2 (8.3%)	G0	10 (71.4%)	G0	20 (68.9%)	<0.001
	G1	12 (50%)	G1	3 (21.5%)	G1	9 (31.1%)	
	G2	10 (41.7%)	G2	1 (7.1%)	G2	0 (0%)	
VIPE	Pos.	10 (41.7%)	Pos.	3 (21.5%)	Pos.	7 (24.2%)	0.011
	Neg.	14 (58.3%)	Neg.	11 (78.5%)	Neg.	22 (75.8%)	

Results

- Concerning the definite MD ears, the grade of VH was significantly associated with hearing loss in LHF, MHF, and HHF
- The grade of CH was also associated with PTA results in LHF and MHF in this group

Results

- Grade of VANV was only related to the hearing loss in the LHF
- Presence of VIPE was not associated with the PTA findings
- As the grade of EH increased, the hearing loss in LHF and MHF significantly deteriorated
- No significant association between the PTA findings and the grades of VH, CH, VANV, and VIPE in the control group

MRI index	Grade	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Grade of VH	≥ G1	100	92.3	96	100
	≥ G2	70.8	100	100	65
	G3	16.7	100	100	39.4
Grade of CH	≥ G1	79.2	92.3	95	70.6
	G2	33.3	100	100	44.8
VANV	≥ G1	91.7	69.2	84.6	81.8
	G2	41.7	92.3	90.9	46.2
VIPE	Positive	58.3	76.9	82.4	50

Accuracy

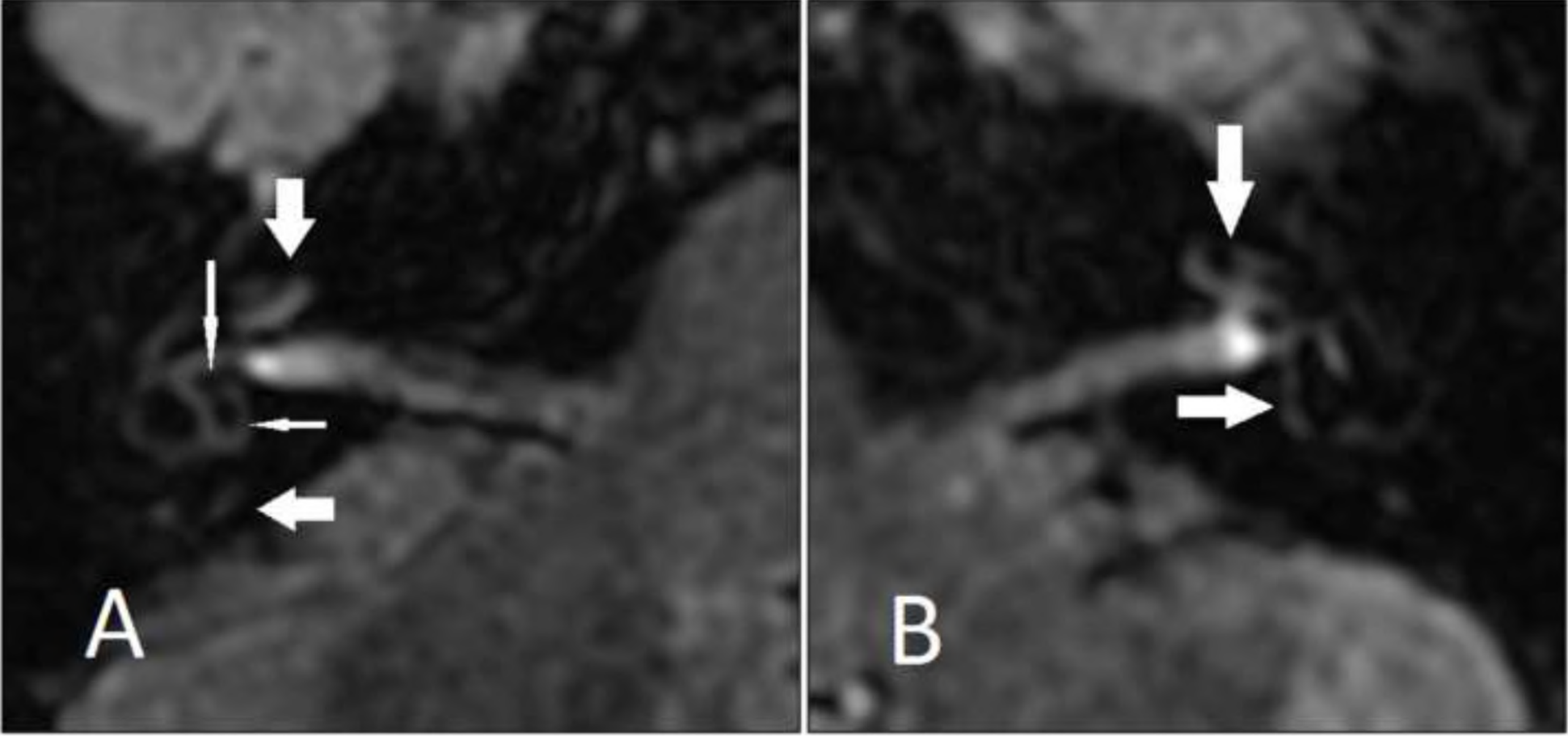
Sensitivity decreases and the specificity increases with higher grades of VH, CH, and VANV

The combination of VH, CH, VANV, and VIPE increases sensitivity and decreases specificity compared to the findings of VH alone

VH and VANV grade ≥ 1 resulted in the highest predictive value of MD

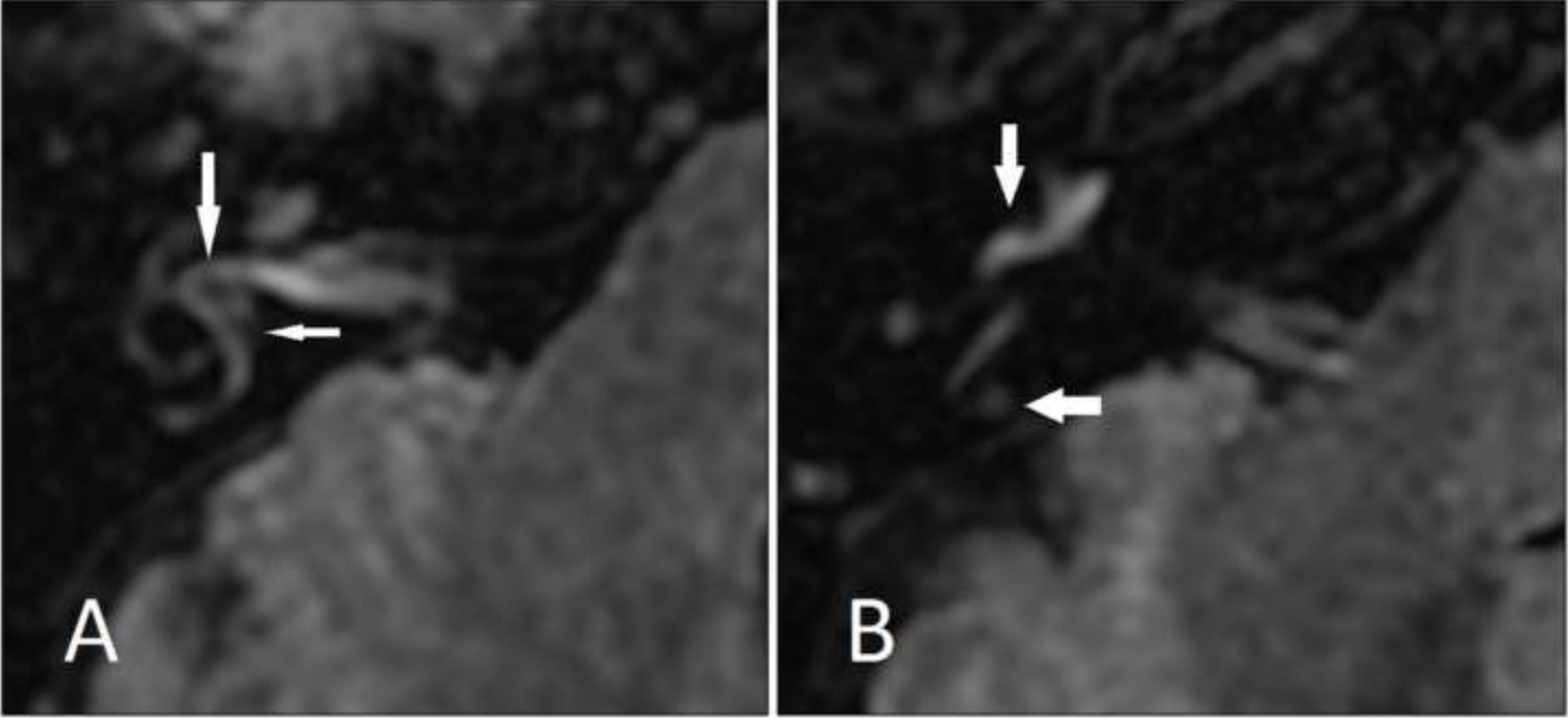
Other reports: sensitivity and specificity of VANV grades 1 and 2 on MRI in the detection of MD to be 90% and 60% for grade 1 and 45% and 85% for grade 2

EH			The hearing threshold in frequency domains of PTA					
Among the MD ears			LHF		MHF		HHF	
Index	Grade	N	Median (IQR) [min-max]	Sig.	Median (IQR) [min-max]	Sig.	Median (IQR) [min-max]	Sig.
VH	G0	0	-	**0.003**	-	**0.007**	-	**0.014**
	G1	7	**10.0 (10.0) [10.0-20.0]**		**10.0 (10.0) [10.0-20.0]**		**10.0 (10.0) [10.0-20.0]**	
	G2	13	**40.0 (55.0) [0.0-60.0]**		**40.0 (55.0) [0.0-60.0]**		**40.0 (50.0) [0.0-60.0]**	
	G3	4	**45.0 (17.0) [40.0-60.0]**		**40.0 (45.0) [0.0-60.0]**		**40.0 (45.0) [0.0-60.0]**	
CH	G0	6	**20.0 (32.5) [0.0-40.0]**	**0.002**	**20.0 (32.5) [0.0-40.0]**	**0.034**	20.0 (32.5) [0.0-40.0]	0.127
	G1	10	**10.0 (32.5) [0.0-60.0]**		**10.0 (32.5) [0.0-60.0]**		10.0 (32.5) [0.0-60.0]	
	G2	8	**50.0 (17.5) [40.0-60.0]**		**50.0 (20.0) [0.0-60.0]**		45.0 (47.5) [0.0-60.0]	
VANV	G0	2	**5.0 (N/A) [0.0-10.0]**	**0.031**	5.0 (N/A) [0.0-10.0]	0.140	5.0 (N/A) [0.0-10.0]	0.275
	G1	12	**20.0 (37.5) [0.0-60.0]**		20.0 (37.5) [0.0-60.0]		20.0 (37.5) [0.0-60.0]	
	G2	10	**50.0 (25.0) [10.0-60.0]**		45.0 (42.5) [0.0-60.0]		40.0 (45.0) [0.0-60.0]	
VIPE	Neg.	10	15.0 (45.0) [0.0-60.0]	0.214	15.0 (45.0) [0.0-60.0]	0.680	15.0 (45.0) [0.0-60.0]	0.697
	Pos.	14	40.0 (32.5) [0.0-60.0]		40.0 (35.0) [0.0-60.0]		30.0 (40.0) [0.0-60.0]	

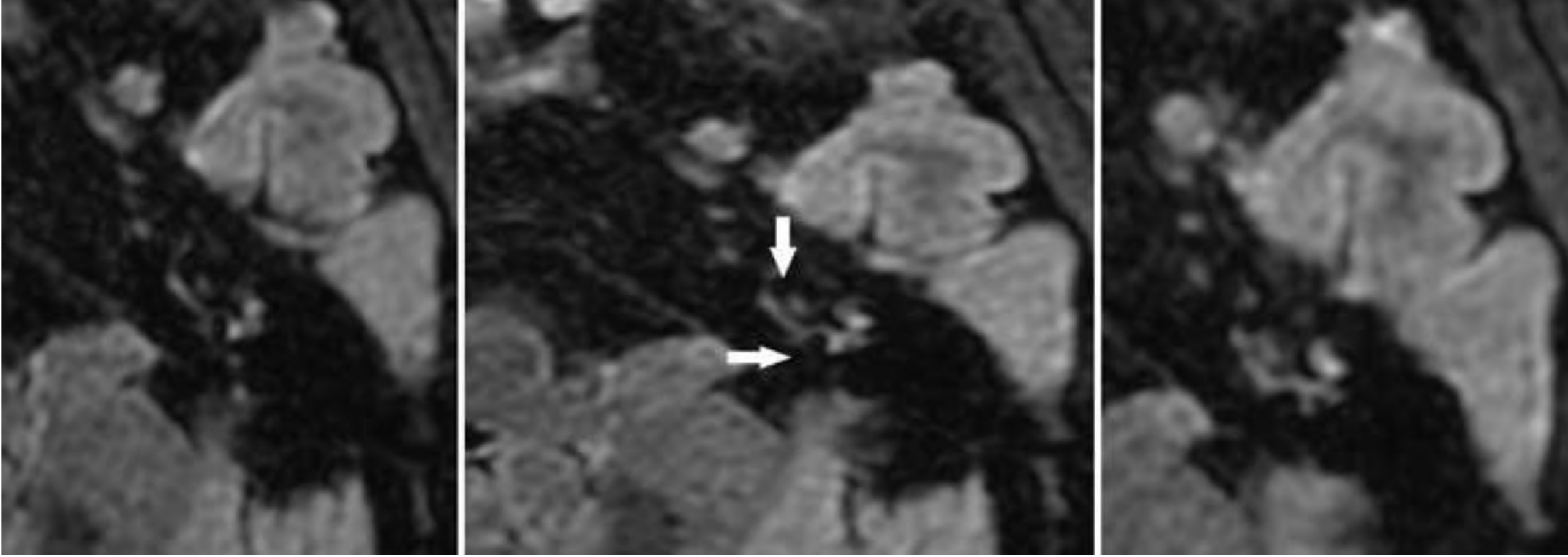


(A) Normal vestibular utricle (horizontal thin arrow), saccule (vertical thin arrow), cochlea (vertical thick arrow), and vestibular aqueduct (horizontal thick arrow) of the right ear.

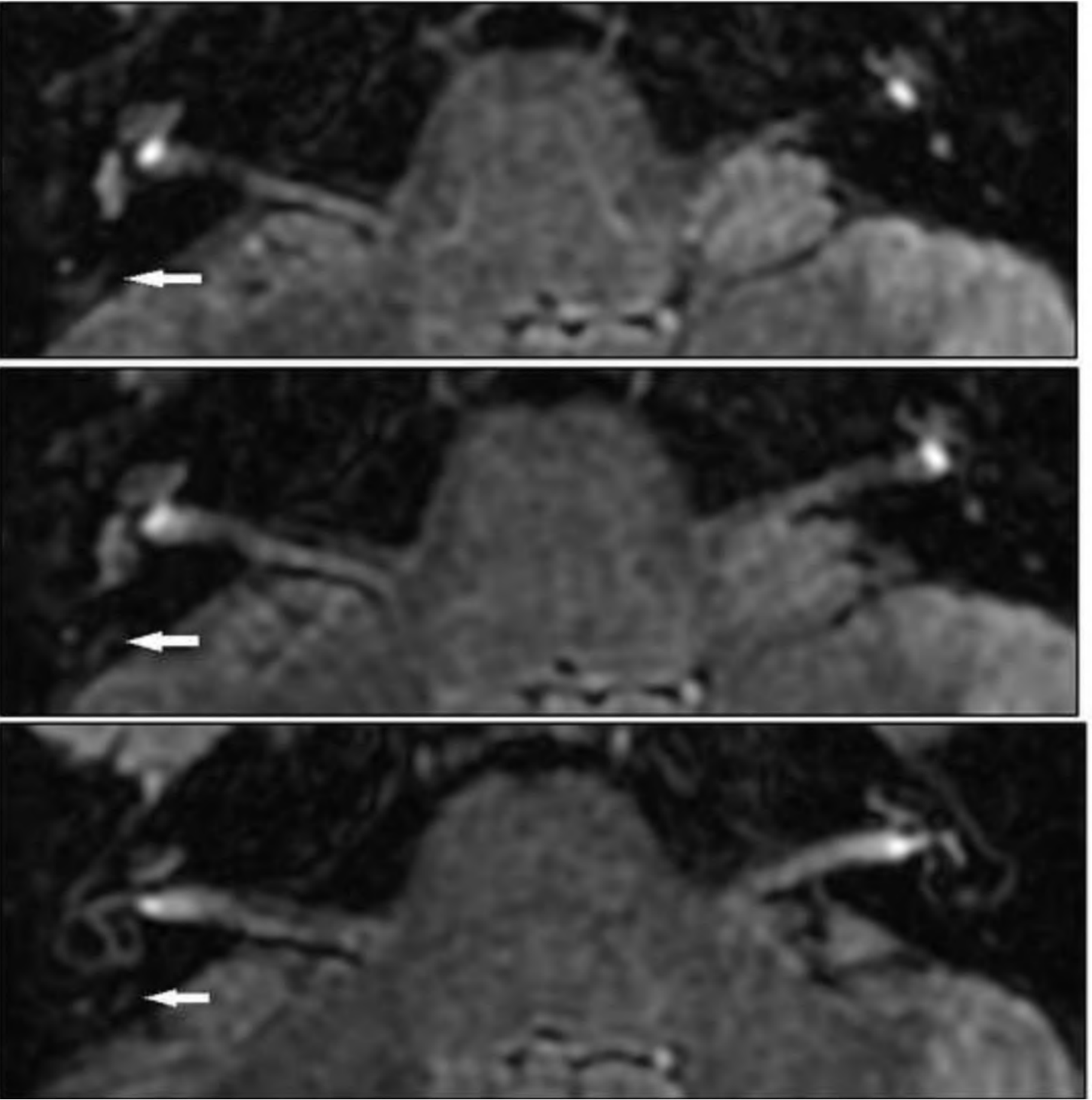
(B) Grade 2 vestibular (horizontal arrow) and grade 2 cochlear (vertical arrow) hydrops of left ear. The vestibular aqueduct was not visible in this ear. She presented with 50 dB hearing loss on the left side.



Confirmed definite Meniere's disease in the right ear.
(A) Saccule (vertical arrow) is larger than vestibule, suggestive of grade 1 vestibular hydrops.
No imaging sign of cochlear hydrops is present.
(B) Vestibular aqueduct (horizontal arrow) is completely visible (grade 0)
visualized increased perilymphatic enhancement (vertical arrow) is present. 20 dB hearing loss of the right ear was detected.

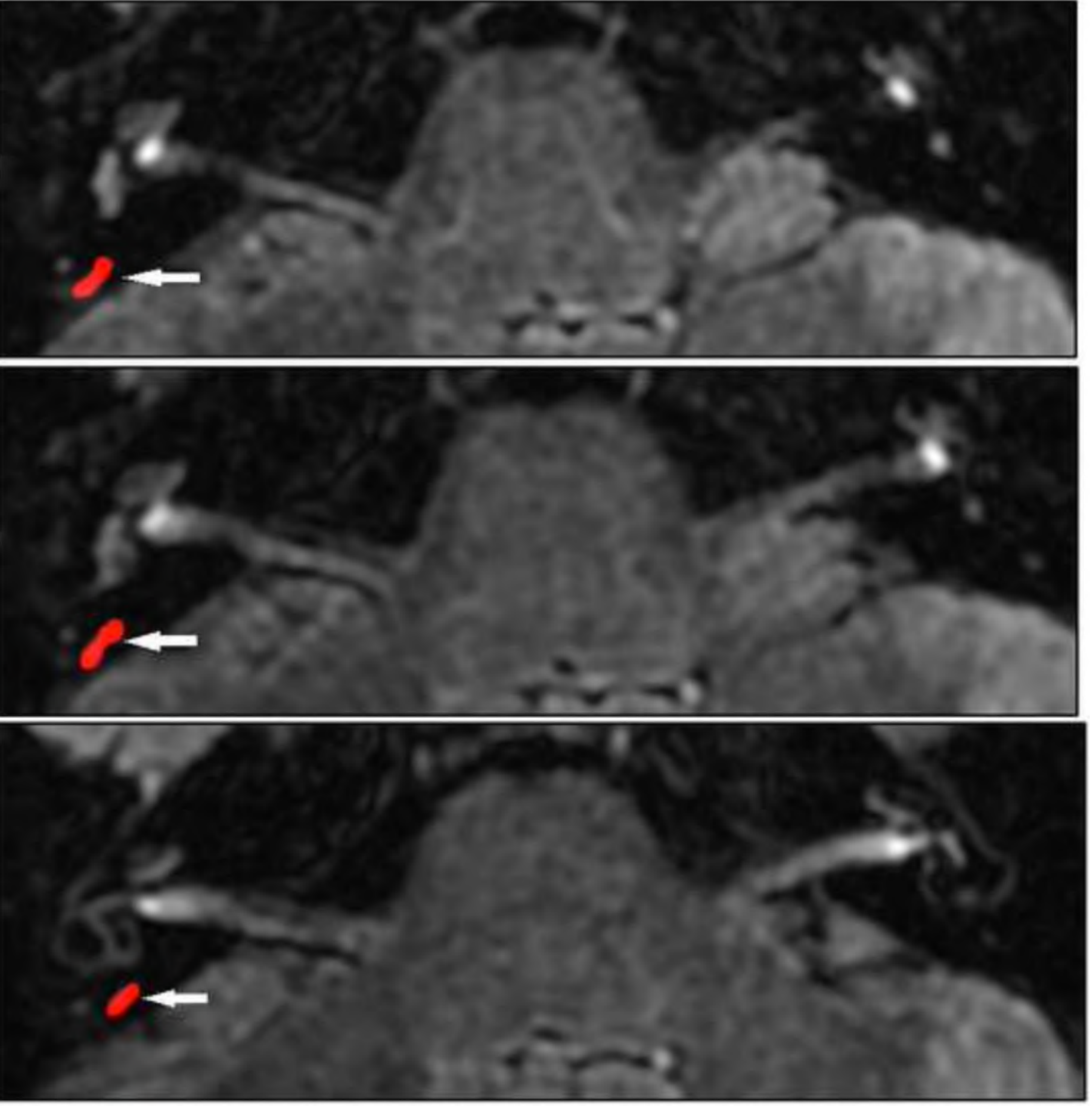


68-year-old female with confirmed definite Meniere’s disease of the left ear.
Complete obliteration of cochlear scala vestibuli (vertical arrow) in favor of grade 2 cochlear hydrops
near-complete vestibular perilymphatic obliteration suggestive of grade 3 vestibular hydrops are present.
60 dB hearing loss was recorded in this ear.
The lower and upper sections are presented on the left and right, respectively.



Three consecutive axial sections of the prev patient

- ***The vestibular aqueduct is completely visible in the right ear (normal ear)***
- ***the vestibular aqueduct is invisible in all three sections on the left side with a confirmed diagnosis of definite MD***



The same figure but with highlighted visible vestibular aqueducts in red overlays

Take Home Message

MRI is a valuable technique in the detection of EH and the diagnosis of MD

Significant association between “the grade of VH, CH, and VANV” and “the PTA findings”

Low-grade VH, CH, and VANV were found in the asymptomatic ears of the unilateral MD patients and the control group


Thanks for your attention