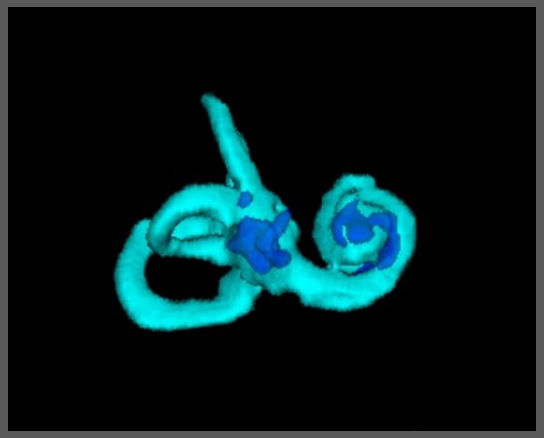
TC 20: Neuro-otology: The dizzy patient, part II

Imaging vestibular function and disorders



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Disclosure

None

Learning objectives

Imaging of the vestibular system

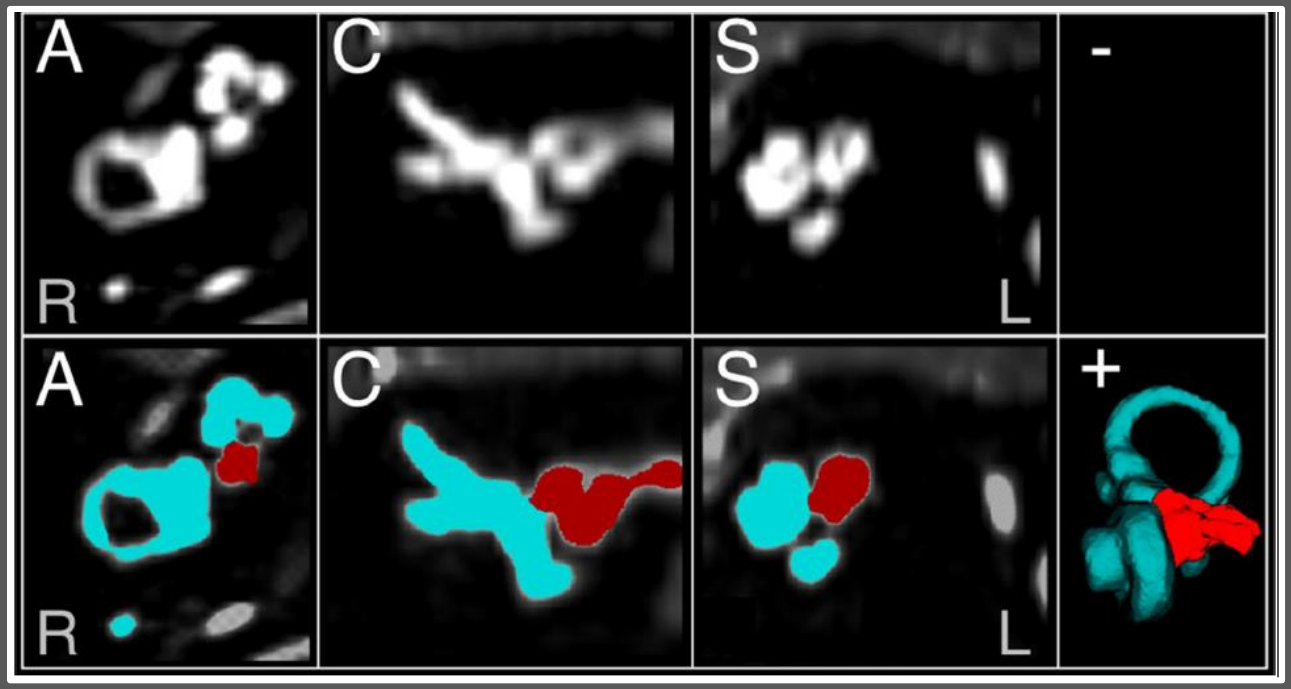
(A) in healthy volunteers
(B) in patients with vestibular disorders

1. of the labyrinth
2. of vestibular structures in the brainstem
3. of areas within the vestibular cortical network

1. Labyrinth

1A. Inner ear/ labyrinth

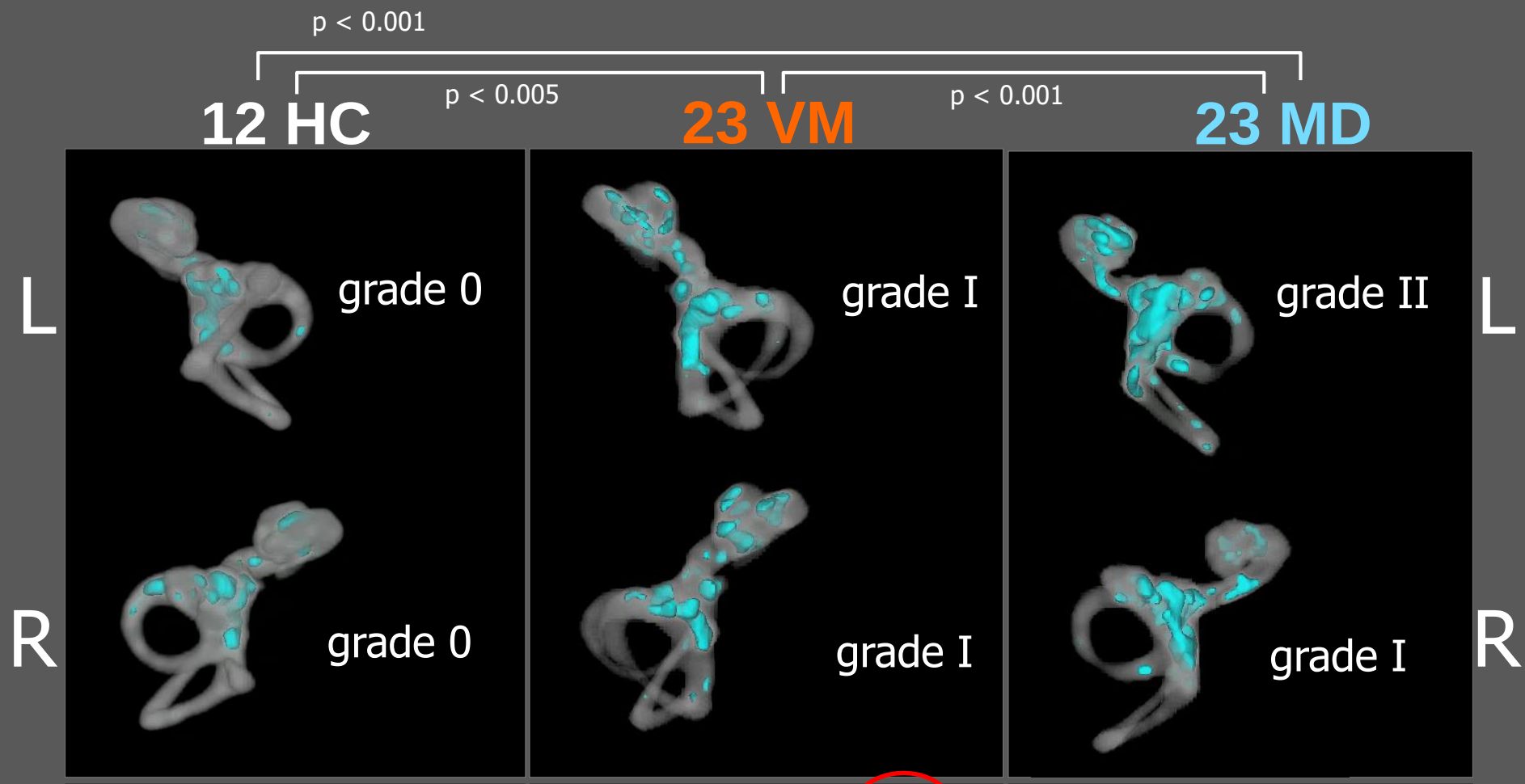
ivMRI of the inner ear bony structures of both ears
(3T, 4h after iv)



Dice score of 89% for the right and 86% for the left ear

Kirsch et al, J Neurol 2019; https://doi.org/10.1007/s00415-019-09488-6

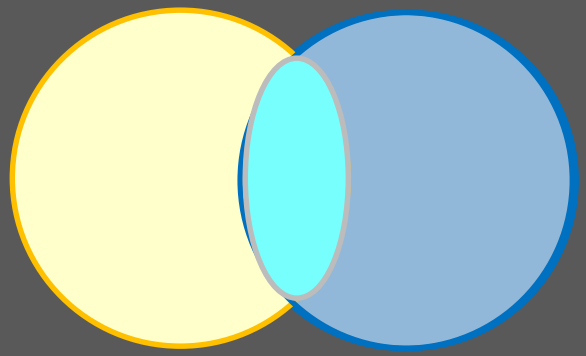
1B. Semiquantitative analysis of ELS with 3D reconstruction 4h after Gadolinium iv



12 HC	23 VM	23 MD
Grade [°] = 0, 100%, symmetrical	Grade [°] = 0.4 , 65 %, symmetrical	Grade [°] = 1.3, 100 %, asymmetrical

Kirsch et al. 2019 in prep.

Significant Overlap in VM and MD



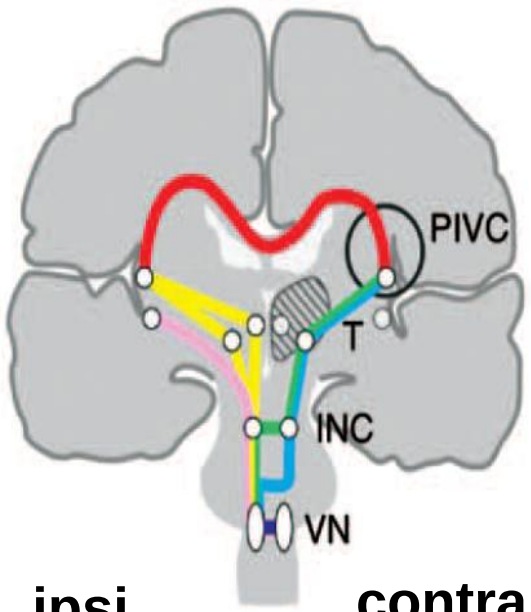
VM: - Thalamic dysfunction of central vestibular and multisensory networks
- ELH in 20% (older classification; grade I-II) to about 68% (newer; grade 0-I), more symmetric; ELS plasticity dependent on disease activity

MD: - ELH in all patients (100%) with higher grading (I-II) and asymmetry
- 3 rare single nucleotide variants in PRKCB, DPT and SEMA3D linked with familial Meniere disease

ELH: common final section of different pathophysiologies ?

2. Vestibular structures in the brainstem

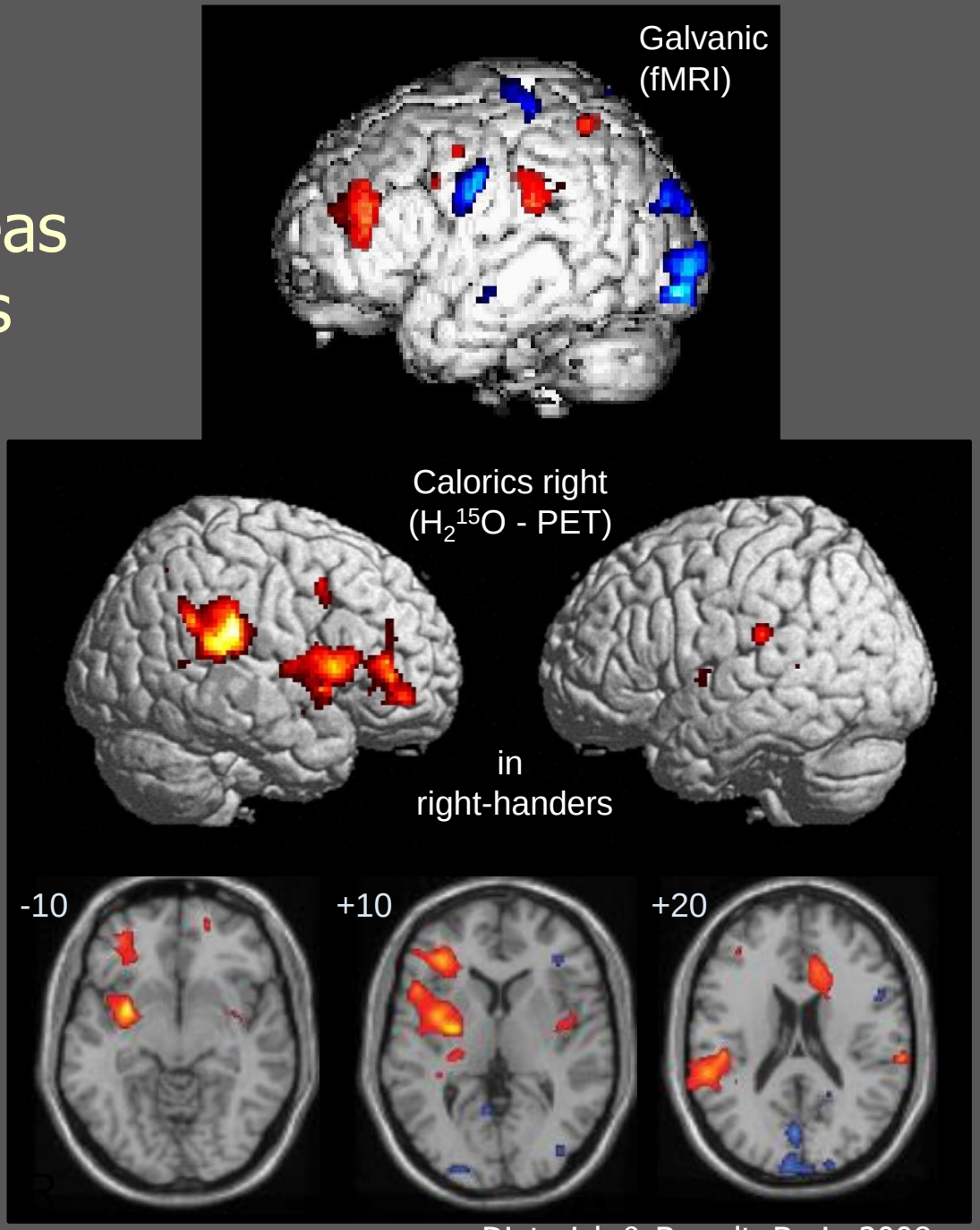
Vestibular brainstem structures



ipsilateral	contralateral
Vestibular nerve Vestibular nucleus (VN): medial VN superior VN	Medial longitudinal fascicle (MLF) Interstitial nucleus of Cajal (INC)
Paramedian thalamus	Posterolateral thalamus: Vim, VPL
Parieto-insular vestibular cortex (PIVC)/Operculum	PIVC/Operculum

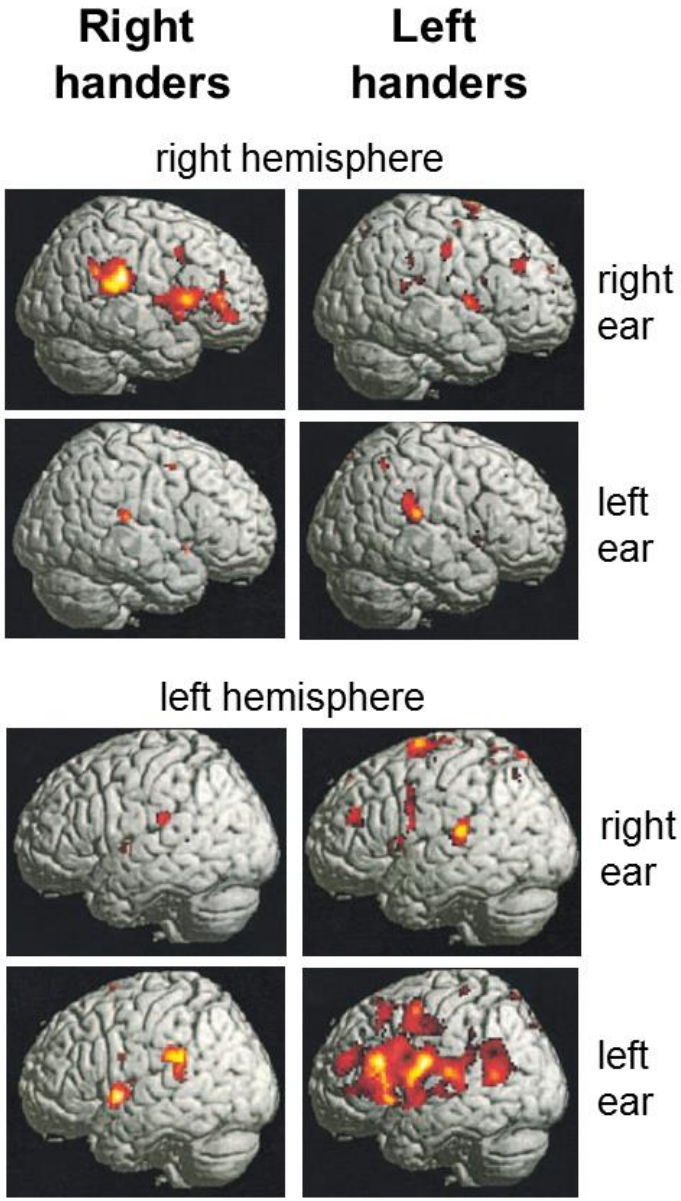
3. Vestibular cortical network

3A. Vestibular cortex areas in humans



Dieterich & Brandt, Brain 2008

from activation studies: PET & fMRI



Dieterich et al., Cerebral Cortex 2003

3 determinants influence the lateralization of vestibular function in the two hemispheres (PET during calorics):

1. Handedness
2. Side of stimulated ear
3. Direction of nystagmus

References

1. Brandt T, Dieterich M, Strupp M. 2013. Vertigo and Dizziness. Common Complaints. Second Edition, Springer, London.

2. Brandt T, Dieterich M. 2017. The dizzy patient: don't forget disorders of the central vestibular system. Nat. Rev. Neurol. 13, 352–362.

3. Dieterich M, Bense S, Lutz ., Drzezga A, Stephan T, Bartenstein P, Brandt T. 2003. Dominance for vestibular cortical function in the non-dominant hemisphere. Cereb. Cortex 13, 994–1007.

4. Lopez C, Blanke O, Mast FW. 2012. The vestibular cortex in the human brain revealed by coordinate-based activation likelihood estimation meta-analysis. Neuroscience 212, 159-179.

5. Kirsch V, Keeser D, Hergenroeder T, Erat O, Ertl-Wagner B, Brandt T, Dieterich M. 2016. Structural and functional connectivity mapping of the vestibular circuitry from human brainstem to cortex. Brain Struct. Funct. 221(3), 1291-308. doi: 10.1007/s00429-014-0971-x.