lek. Emilia Wnuk

Streszczenie w języku angielskim *(Abstract)*

Evaluation of currently used radiological criteria in the diagnostics of Ménière's disease.

Introduction

Ménière's disease (MD) is an inner ear disorder characterized by vertigo episodes, fluctuating low-frequency hearing loss, tinnitus, and aural fullness. The hydropic dilatation of endolymphatic structures (EH) was found in post-mortem studies of temporal bone specimens of patients with MD and is claimed to be a cause of disease.

For many years, the *in vivo* assessment of the EH was not possible. The diagnosis of MD was based on the patient's symptoms, clinical findings, and functional test and was the diagnosis of exclusion.

With the development of magnetic resonance imaging (MR) and the discovery that the intravenously administered contrast moves into perilymphatic spaces of the inner ear, whereas not to the endolymphatic structures, visualization of endolymphatic structures has become possible.

The two principal sequences applied to EH imaging using MR exist, and several scales of EH assessment were proposed in the literature. It results in a discrepancy in the reported frequency of EH, potentially due to the radiological criteria used. Most researchers agree that EH accompanies MD, but it is sometimes present in healthy individuals and in other MD-like pathologies of the inner ear. Additional radiological features are sought, including the degree of enhancement of inner ear structures (PE), which could become a biomarker of disease. Since this is a new method in diagnostics, many issues still need to be clarified and standards established regarding the methodology of MR and evaluation of images.

My doctoral dissertation consists of a series of published manuscripts presenting the results of MR studies for the first time introduced in Poland into radiological diagnostics in Ménière's disease. At the same time, all Polish publications on this subject (cited at the end of this dissertation as "outside the series" come from the center where I work, which is the 2nd Department of Clinical Radiology of the Medical University of Warsaw and the Department

of Otorhinolaryngology, Head and Neck Surgery of the Medical University of Warsaw, with which I cooperate in this regard.

Manuscript #1 in the dissertation series

__Wnuk E__, Lachowska M, Jasińska-Nowacka A, Maj E, Rowiński O, Niemczyk K. Detailed insight into magnetic resonance assessment of Ménière's disease – description of methodology and imaging findings in a case series. Polish Journal of Radiology. 2022; 87: e354–e362. DOI: 10.5114/pjr.2022.117971

The manuscript presents the research protocol with a detailed description of the methodology and a detailed explanation of magnetic resonance images evaluation of the structures of the inner ear, presented on the examples of seven patients with clinically defined unilateral Ménière's disease. All applied MR sequences, their parameters, used receive coil, method, and amount of administrated contrast agent were presented. The EH assessment scale for both the cochlea and the vestibule, according to the method described by Barath et al. and its modification by Bernaerts et al., was explained in detail. The descriptions were supplemented with MR scans, which makes this method easier to understand. Furthermore, a review of the literature on EH imaging is included. This manuscript may be an instruction on creating and implementing a diagnostic protocol for patients with MD and how the results should be interpreted according to current knowledge.

Manuscript #2 in the dissertation series

__Wnuk E__, Lachowska M, Jasińska-Nowacka A, Maj E, Niemczyk K. Reliability of endolymphatic hydrops qualitative assessment in magnetic resonance imaging. J. Clin. Med. 2023, 12(1), 202. DOI. 10.3390/jcm12010202

The study evaluated MR images obtained using the contrast-delayed three dimensional-fluid-attenuated inversion recovery sequence (3D-FLAIR) of 110 patients with suspected MD. The images were assessed independently by three researchers who were unaware of the patients' clinical status. Two of them were radiologists with many years of experience, and one was an otorhinolaryngologist who was taught the MR assessment method during a short training in this field. In total, 220 ears were evaluated using four parameters: cochlear endolymphatic hydrops (CoEH) in a three-point scale proposed by Barath et al., vestibular endolymphatic hydrops (VEH) in a three-point scale proposed by Barath et al. and on a four-point scale proposed by Bernaerts et al., and enhancement of the inner ear structures.

The study aimed to evaluate if the qualitative assessment of the 3D-FLAIR sequence using the above mentioned criteria is consistent between the observers and whether it is easy to learn. In addition, all the MR assessed endolymphatic hydrops features were analyzed to calculate the sensitivity and specificity of the method.

When analyzing the presence of hydrops in the symptomatic MD ears, CoEH was found in 76-80% (depending on the observer), Barath VEH in 74.7%, Bernaerts VEH in 81.3-82.7%, and PE was present in 58.7-62.7% of symptomatic ears. However, in asymptomatic ears, the prevalence of these criteria was significantly lower. CoEH was present in 2.7-8.2% of ears, Barath VEH in 2.7%, Bernaerts VEH in 11%, and PE in 2.7-5.5%. It was also low in ears with other MD-like symptoms, 4.5-6%, 4.5%, 7.5%, and 13.4%, respectively. Analyzing these above mentioned features together gives a high sensitivity of 0.84-0.87 and a specificity of 0.82-0.88 for this assessment method for ears with MD.

At the same time, significant inter-observer differences in assessing the CoEH parameter were observed. This parameter was more complicated to grade for the observer after a short training in MR evaluation (differences between radiologists and unexperienced observer 8% and 13%). However, even between radiologists, the differences in the CoEH parameter evaluation were significant (5%). However, after a more detailed analysis of the obtained results, it turned out that the problem was not to distinguish a pathologically changed cochlea from a normal cochlea but to correctly assign the severity of the pathology. In VEH staging using both scales, experienced observers were consistent in their assessment of 220 ears. Only the unexperienced observer's assessments differed slightly. However, still, the agreement of all researchers for this parameter was high. Same with the last criterion – increased perilymphatic enhancement.

Conclusions

The results of presented studies constituting the series of publications of my doctoral dissertation prove that MR visualization of endolymphatic and perilymphatic structures of the inner ear is possible. They show that radiological criteria of EH and PE occur much more often in ears with MD symptoms than in asymptomatic ears or ears with MD-like symptoms. Therefore they might be a biomarker of MD, supporting the diagnosis, especially in atypical and early cases of MD. Evaluation of MR scans of vestibular endolymphatic structures using 3D-FLAIR is easy to learn and repeatable. The evaluation of cochlear endolymphatic structures might be more complicated; however, the diagnosis of CoEH itself using MR

is not complicated, and its gradation is, even for experienced observers. It seems that another diagnostic method of CoEH (perhaps a different MR sequence) should be sought to monitor the severity of the pathology.