Even though intracranial hypertension is usually a neurosurgical pathology, sometimes an ophthalmologist is the first doctor such patients visit, most often in a primary healthcare clinic. At the same time, as practice shows, not all ophthalmologists are well aware of this pathology [1]

A novel bi-channel deep-learning variational autoencoder (biVAE) model was trained using 1498 optical coherence tomography (OCT) scans of 125 subjects over time from the Idiopathic Intracranial Hypertension Treatment Trial (IIHTT) and 791 OCT scans of 96 control subjects from the University of Iowa. An independent test dataset of 70 eyes from 70 papilledema subjects was used to evaluate the ability of the biVAE model to quantify and reconstruct the papilledema spatial patterns from input OCT scans using only two variables.

Results: The montage color maps of the retinal nerve fiber layer (RNFL) and total retinal thickness (TRT) produced by the biVAE model provided an organized visualization of the variety of morphological patterns of optic disc edema (including differing patterns at similar thickness levels). Treatment effects of acetazolamide versus placebo in the IIHTT were also demonstrated in the latent space. In image reconstruction, the mean signed peripapillary retinal nerve fiber layer thickness (pRNFLT) difference ± SD was -0.12 ± 17.34 μm, the absolute pRNFLT difference was 13.68 ± 10.65 μm, and the RNFL structural similarity index reached 0.91 ± 0.05.

Conclusions: A wide array of structural patterns of papilledema, integrating the magnitude of disc edema with underlying disc and retinal morphology, can be quantified by just two latent variables.

Translational relevance: A biVAE model encodes structural patterns, as well as the correlation between channels, and may be applied to visualize individuals or populations with papilledema throughout treatment [2].

[1]
Serova NK, Eliseeva NM. Zastoinyi disk zritel'nogo nerva kak priznak vnutricherepnoi gipertenzii [Papilledema as a sign of intracranial hypertension]. Vestn Oftalmol. 2022;138(4):87-93. Russian. doi: 10.17116/oftalma202213804187. PMID: 36004596.

[2]
Wang JR, Linton EF, Johnson BA, Kupersmith MJ, Garvin MK, Kardon RH. Visualization of Optic Nerve Structural Patterns in Papilledema Using Deep Learning Variational Autoencoders. Transl Vis Sci Technol. 2024 Jan 2;13(1):13. doi: 10.1167/tvst.13.1.13. PMID: 38231498.

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