Clinical Features Distinguishing Diabetic Retinopathy Severity Using Artificial Intelligence

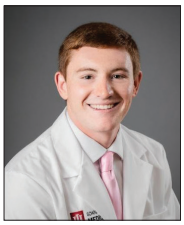
Happe M, Gill H, Salem DH, Janga SC, Hajrasouliha A

Background and Hypothesis: 1 in 29 American diabetics suffer from diabetic retinopathy (DR), the weakening of blood vessels in the retina. DR goes undetected in nearly 50% of diabetics, allowing DR to steal the vision of many Americans. We hypothesize that increasing the rate and ease of diagnosing DR by introducing artificial intelligence-based methods in primary medical clinics will increase the long-term preservation of ocular health in diabetic patients.

Project Methods: This retrospective cohort study was conducted under approval from the Institutional Review Board of Indiana University School of Medicine. Images were deidentified and no consent was taken due to the nature of this retrospective study. We categorized 676 patient files based upon HbA1c, severity of non-proliferative diabetic retinopathy (NPDR), and proliferative diabetic retinopathy (PDR). Retinal images were annotated to highlight common features of DR: microaneurysms, hemorrhages, cotton wool spots, exudates, and neovascularization. The VGG Image Annotator application used for annotations allowed us to save structure coordinates into a separate database for future training of the artificial intelligence system.

Results: 228 (33.7%) of patients were diagnosed with diabetes, and 143 (62.7%) of those were diagnosed with DR. Two-sample t tests found significant differences between the HbA1c values of all diabetics compared to diabetics without retinopathy ($p<0.007$) and between all severities of DR versus diabetics without retinopathy ($p<0.002$). 283 eyes were diagnosed with a form of DR in this study: 37 mild NPDR, 42 moderate NPDR, 56 severe NPDR, and 148 PDR eyes.

Potential Impact: With the dataset of coordinates and HbA1c values from this experiment, we aim to train an artificial intelligence system to diagnose DR through retinal imaging. The goal of this system is to be conveniently used in primary medical clinics to increase the detection rate of DR to preserve the ocular health of millions of future Americans.



NIH NEI-T35 Award

Michael Happe is a third-year medical student, who is currently interested in ophthalmology due to its blend of surgery, patient care, and immediate impact on the lives of patients.

"The most important takeaway from my research has been that there are always improvements to be made. As an Ophthalmologist, it will be my job to provide the best possible care to patients, and I believe that my research is a perfect example of enhancing diagnostic tests in order to ultimately improve the health outcomes of patients. I have enjoyed working alongside experts in the field and learning more about ophthalmology through my research. I look forward to more opportunities of continued learning in the future."

Protease-Activated-Receptors 1 and 2 are Essential in the Initiation of Food Allergy Early in Life

Miller J, Martin A, Cook-Mills J

Background and Hypothesis: Because food allergies can be life-threatening, it is imperative to investigate the underlying pathways of food allergy initiation to progress towards treatment and prevention. Food allergies occur at an increased rate in children with altered skin barriers. Previous RNAseq studies have identified increased ApoE gene expression in mouse pups with skin barrier mutations sensitized with house dust mite and peanut allergens. Furthermore, PAR2 has been shown to be involved in the synthesis pathway of ApoE when activated by household allergens. We hypothesize that PAR2 is necessary for the initiation of food allergy in mice with skin barrier mutations.

Project Methods: Pups heterozygous for skin barrier mutations in FLG and Tmem79 were sensitized with Alternaria alternata (Alt) and peanut extract (PNE) on postnatal days 3, 6, 9, 13, and 15. Pups received injections of PAR1 or PAR2 antagonist, no antagonist, or saline before each sensitization. At day 17, the pups received a PNE oral gavage. Rectal temperatures were incrementally measured for 80 minutes after the gavage to monitor anaphylaxis. Tissues were collected 8 hours after the gavage. Skin punches and intestine are currently being processed and analyzed by qPCR for IL33, OSM, and Areg.

Results: Statistical analysis was completed using area under the curve by summation of average temperature changes for each pup. Pups that received PAR1 or PAR2 antagonists and application of Alt and PNE did not exhibit significant temperature drops whereas pups that received no inhibitor and Alt and PNE did undergo anaphylaxis, indicating blocking PAR1 and PAR2 blocked anaphylaxis. There were no statistically significant differences between male and female pup responses.

Conclusion: The results of this study indicate that PAR2 and PAR1 are essential for development of food allergy and are potential cellular targets for treatment and prevention of food allergy early in life.

NIH NHLBI-T35 Award

Jessica Miller is a third-year medical student, who is currently interested in internal medicine.

"Completing research in an animal model for the first time gave me a deep appreciation for the time, effort, and sacrifice that goes into the biomedical discoveries that shape medicine. Although I will not be continuing research involving animals in the future, I am grateful for the animals and the researchers who work with animals to discover the pathology, physiology, and pharmacology that leads to improved healthcare. Additionally, I will always be grateful for Dr. Cook-Mills and her lab for teaching me the basic ropes of allergy/immunology research as well as the importance of team collaboration within a research laboratory."