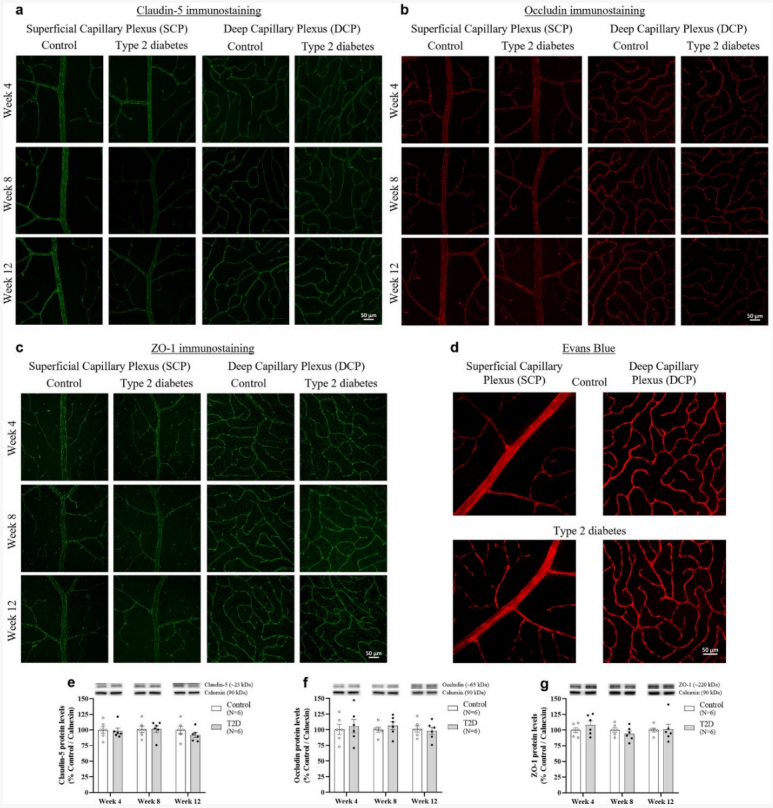
AI-inspired texture analysis detects 'silent' retinal damage in early diabetes

GA, UNITED STATES, December 9, 2025 /EINPresswire.com/ -- Researchers have identified subtle, early-stage retinal alterations in type 2 diabetes using texture-based optical coherence tomography (OCT) analysis, revealing a promising tool for detecting diabetic retinopathy (DR) before visible clinical signs emerge. The study demonstrated that specific OCT texture metrics—such as autocorrelation, correlation, and homogeneity—changed significantly in diabetic animals, even when structural and molecular damage was minimal. These findings suggest that texture analysis can quantify early retinal disorganization invisible to traditional imaging, potentially enabling earlier intervention and reducing blindness risk. This novel approach may provide clinicians with a powerful diagnostic tool to identify “silent” disease stages long before irreversible vision loss occurs.



Diabetes triggers slight immunoreactive changes in tight junction proteins, without changes in retinal vascular permeability.

Diabetic retinopathy (DR) is a leading cause of blindness among working-age adults, affecting more than 130 million people worldwide. Although advances in ophthalmic imaging have improved disease monitoring, most patients are diagnosed only after years of unrecognized retinal damage. Early molecular and cellular changes—including neurodegeneration, inflammation, and vascular dysfunction—often remain undetectable with standard methods such as fundus photography or angiography. As a result, patients may experience irreversible vision impairment before diagnosis. Due to these limitations, new noninvasive imaging biomarkers are urgently needed to detect subclinical retinal alterations at the earliest stages of diabetes.

A research team from the University of Coimbra, Portugal, has developed a texture-based analysis of optical coherence tomography (OCT) images capable of detecting early retinal changes in type 2 diabetes. The study, published (DOI: 10.1186/s40662-025-00451-3) in Eye and Vision on September 3, 2025, used a high-fat-diet and low-dose streptozotocin rat model to monitor retinal alterations over 12 weeks. By quantifying microscopic texture variations, the method revealed early neurovascular abnormalities that occurred well before traditional biomarkers or vascular leakage.

Using advanced image analysis, the researchers evaluated over 80 retinal scans from diabetic and control rats, applying a gray-level co-occurrence matrix (GLCM) approach to quantify texture parameters across retinal layers. Among the 20 features examined, eight—including autocorrelation, cluster prominence, correlation, homogeneity, information measure of correlation II (IMCII), inverse difference moment normalised (IDN), inverse difference normalised (INN), and sum average—showed significant changes in diabetic retinas, particularly in the inner plexiform layer (IPL) and photoreceptor segments (IS/OS). Interestingly, seven of these metrics had also been altered in a previous study using a type 1 diabetes model, reinforcing their diagnostic consistency. Despite minimal thinning and delayed oscillatory potentials, the retinas displayed no major inflammation or vascular leakage, confirming that texture changes precede overt pathology. The findings highlight texture analysis as a sensitive, quantitative method for detecting early structural disorganization in the retina—potentially bridging the gap between biological alterations and clinical diagnosis.

“Our results demonstrate that texture analysis can uncover minute retinal changes long before DR becomes clinically visible,” said Professor António Francisco Ambrósio, co-senior author of the study. “By capturing subtle structural signals within OCT images, this approach opens a new diagnostic window into the earliest disease processes. It offers a way to identify high-risk patients before permanent vision damage occurs, supporting earlier treatment and better outcomes. The coherence of these texture metrics across diabetes models strengthens their potential as universal early biomarkers.”

This research paves the way for developing AI-assisted diagnostic tools that automatically screen for preclinical DR based on retinal texture signatures. Integrating this analysis into routine OCT imaging could allow ophthalmologists to identify patients who show microscopic structural disruption—even when their vision appears normal. Such early detection may help tailor personalized care, prevent irreversible retinal damage, and reduce the global burden of diabetic blindness. Further clinical trials are now needed to validate these findings in human subjects and refine algorithms for large-scale screening and teleophthalmology applications.

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