Eye Care – A Window to the Heart

Microvascular changes that occur with different heart conditions can often be detected in the eye with advanced imaging techniques. Several cardiology experts are exploring the possibility of assessing certain cardiovascular diseases through eye examination with optical coherence tomography angiography (OCTA) - a relatively new imaging tool that can map blood flow in the eye in detail. Professor Patrick De Boever, working at the University of Antwerp and Hasselt University, in Belgium, is one of the experts pioneering minimally invasive, time and resource saving OCTA for cardiological investigations.

Instead of diagnosing heart conditions through complex techniques, the eye can provide a convenient and accurate source of information about the cardiovascular system and the microvasculature of the heart.

"Looking at the eye can be very interesting, because it's very easy and it can really tell you something about the microcirculation," said Prof. De Boever. "This is possible because the eye is optically transparent, and so, with very easy imaging techniques, we can look at the back of the eye or the retina. The retina reveals a great deal of relevant information."

Sophisticated new technology

There are different techniques for imaging the retinal microvasculature, including the classical digital camera to collect a 2D image. The blood vessels can also be explored using optimal coherence tomography (OCT). The newer variant: optical coherence tomography angiography (OCTA) can detect the movement of red blood cells in the retinal blood vessels and the technology allows visualization of the tiniest vessels in detail.

"OCTA allows you to go to microlevel analysis of the microcirculation to examine changes in retinal vessel parameters and metrics and it is a promising, non-invasive technique for vascular assessments," remarked Prof. De Boever.

Digital retinal images can be processed to calculate metrics such as the dimensions of vessels, including arterial widths, venule widths, and the ratios between vessels. Information linked to the geometric patterns can also be extracted, such as how many times these vessels branch, the complexity of the branches, the straightness of the vessels, the curviness of the vessels. An impression of the complexity of the vessel pattern can be obtained using impression of the complex vessel pattern can be obtained using fractal dimensions.

"These types of measurements have been used already for a long time to associate retinal microvascular changes with different cardiovascular outcomes," said Prof. De Boever.

Proven indicator of cardiovascular risk

In particular, changes in the values of the widths of retinal vessels have been shown to be a good (predictive) indicator for the development of hypertension.

"The Xephilio OCT-A1 allows you to go to microlevel analysis of the microcirculation to examine changes in retinal vessel parameters and metrics."

Professor Patrick De Boever, Research & Innovation Manager at the University of Antwerp and Hasselt University, Belgium.

Patrick De Boever is research and innovation manager at the University of Antwerp. He has a part-time appointment as a professor at Hasselt University. Previously, he was the team leader of the MONA group (Flemish Institute for Technology, VITO), focusing on retinal image analysis using artificial intelligence for diagnostic screening and epidemiology research. The team's work resulted in August 2021 in launching the digital health startup company MONA with the first product on diabetic eye screening. He began his research career at the Belgian Nuclear Research Centre. He holds a Ph.D. in Applied Biological Sciences from Ghent University and a Master of Science in Bio-Engineering from that same university.

In a study of more than 10,000 participants, with follow-up of over 10 years, smaller retinal arterioles were associated with a significantly higher risk (29%) of developing hypertension. Wider retinal venules were aso linked with increased cardiovascular risk[1].

This has been taken further in other studies. A study published in 2016 identified that narrowing of the arterioles and the widening of venules (changes in vessel width calibers) were linked with different cardiovascular outcomes, which included atherosclerotic cardiovascular events up to different cardiovascular disease endpoints, like heart failure stroke and even death caused by cardiovascular disease[2]. The researchers went on to use the dimensions of the vessels as an additional risk classification mark (the Pooled Cohort Equation or PCE score) and classify patients with a PCE score according to low risk, medium or high risk. This is obviously important in follow-up of patients with significant risks. There is a link between venule width, hypertrophy and worse diastolic and systolic function[3].

Prediction power

Deep learning and artificial intelligence (AI) are beginning to come to the fore in identifying clinical patterns obtained with digital retinal images.

For example, in another study, a significant association was found between information that was extracted using deep learning from the fundus image and the arterial calcium score[4].

"This is really interesting, because you get the same information from this fundus image, as you can obtain from a CT scan," added Prof. De Boever. "The researchers used a new risk factor for this rating – the retina coronary artery calcium (RetiCAC) risk score – to classify patients into risk categories. And they identified that those patients could really benefit from having an additional fundus image."

Prof. De Boever is very positive about the potential of AI in this context:

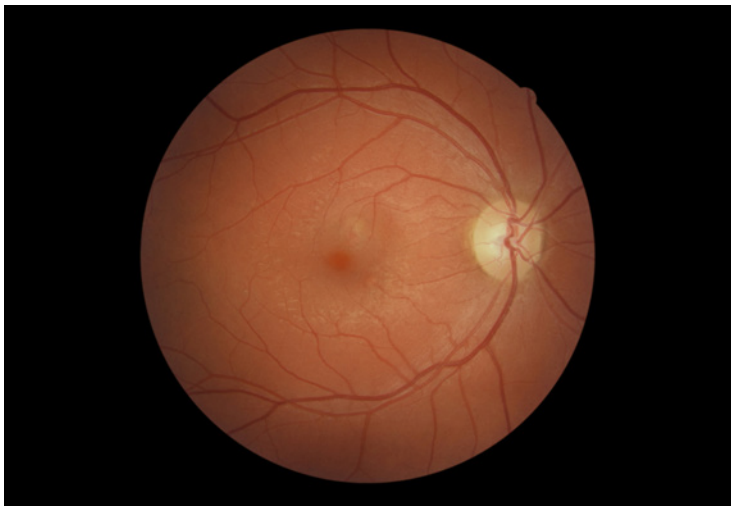
"There's a lot of very promising research about algorithms with an excellent prediction power, but the challenge is now to make the translation to the clinic, and to the applicability, and to take it from the research to the practice," he said.

Growing body of information

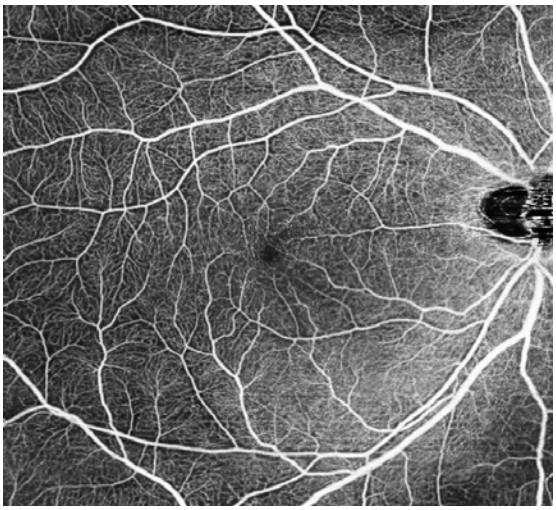
While much more research will be carried out in this field, eye examinations already show great promise in cardiology.

"Eye exams are fast and convenient (less than five minutes); and there are

Fundus image



OCT angiography scan



different image modalities that give information about structural and functional vascular information," said Prof. De Boever. "There is now a growing body of information available on eye exams as predictive tools in medicine and their use for cardiovascular follow-up and cardiovascular disease management."

Canon Medical Eye Care

Alongside its reputation as a leader in MRI, CT and Ultrasound technology, Canon Medical is becoming increasingly recognized in ophthalmology for its range of high-quality eye care imaging systems. In the context of using eye examinations to provide insights in cardiology, Canon's range of ophthalmic diagnostic equipment includes an advanced optical computed tomography angiography (OCTA) system – the Xephilio OCT-A1 and the Xephilio OCT-S1. //

References

1 *Ding et. al (2014); Journal of Hypertension, 32(2): 207–215.*
2 *Siedleman et. al (2016); Circulation, 134(18):1328-1338.*
3 *Chandra et al. (2019); European Journal of Heart Failure, 21, 1207–1215*
4 *Rim et al. (2021);Lancet Digit Health, 3: e306–16*

Canon Medical OCTA

Canon Medical's OCTA system – the Xephilio OCT-A1 and OCT-S1 -offer superior image quality and a host of automated features to optimize and simplify examinations. The system has a high scanning speed for short examination times, enabling increased efficiency and patient comfort.

Non-invasive examination, results within seconds

OCT Angio does not require fluorescein injection or pupil dilation, and the examination takes only seconds. SLO-based real-time tracking minimizes artefacts. Sophisticated image post-processing with 3D projection artefact removal enables excellent image quality.

Angio Expert with freely selectable layers

With OCT angiography even the smallest blood vessels can be observed in 2D and 3D. With Canon's OCT Angio software, you can freely select layers to create the preferred image. Layers can be defined based on automatic segmentation or as a custom offset. Canon Medical's Angio Expert software provides a complete set of manual and automated analysis tools including the latest innovation "Intelligent Denoise" a deeplearning imaging noise reduction software.