Imaging in uveitis

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In busy uveitis and retina clinics, we as doctors are often faced with challenging situations where the patient is at high risk of rapidly losing vision and developing permanent blindness if action is not taken, possibly on the same day. Therefore, it becomes imperative for the clinician to accurately narrow down the differential diagnosis because certain entities may have diametrically opposite treatment. It is desirable for a clinician to obtain as much help as possible using ancillary investigations available in the clinic with tools such as fundus photography, fluorescein and indocyanine green angiography (FA and ICGA), and optical coherence tomography (OCT) and OCT angiography (OCTA). These imaging modalities have the potential to allow identification of subtle phenotypes and manifestations leading to disease recognition without waiting for elaborate laboratory results, which can take several days or weeks.

Vision is the most important clinical endpoint in the management of uveitis. It is necessary to salvage the patient's vision while ensuring minimal damage to the retinochoroidal tissue. Both OCT and OCTA have been proven to be indispensable in the management of eyes with uveitis because of two reasons: (1) OCT and OCTA provide a very accurate analysis of retinochoroidal damage without any intervention including injection of dye or obtaining ocular biopsies, and (2) OCT and OCTA features are correlated well with visual acuity and other functions of vision such as contrast sensitivity and visual fields. Therefore, OCT and OCTA are now a '*mandatory'* technology in any ophthalmic institute that manages patients with uveitis. While this technology has been introduced since more than a decade now, there are several applications of OCT and OCTA that are yet to be explored.

The findings in the thesis further support the growing role of OCT and OCTA in the assessment of patients with uveitis. Using these two tools in a complementary manner, it is possible to distinguish an infective condition (example viral retinitis) from a malignancy (such as vitreoretinal lymphoma) without waiting for laboratory tests or pathological samples. While the results of every new technology should be considered with caution, the analysis of OCT and OCTA have revealed it to be reliable so far. It is necessary to mention that imaging with OCT and OCTA does not replace conventional testing such as viral assays or tissue biopsy. However, they provide valuable clues in a busy clinic helping us to obtain targeted investigations and prevent institution of an incorrect treatment. With further research and introduction of tools such as artificial intelligence, there is an immense scope of the use of this technology in day-to-day practice.

We have used either semi-automatic or fully automatic techniques for image quantification on OCT and OCTA in the thesis. These techniques can be applied easily without complex image analysis in a laboratory setup, and most of the tools are available for free worldwide. The image analyses algorithms can be saved as '*macros'* and shared across platforms with researchers globally allowing rapid and widespread use of quantification tools. Due to the ease of use, accuracy and reproducibility, these quantification techniques are already being applied in the assessment of medical retinal diseases such as diabetic retinopathy, age-related macular degeneration, retinal vein occlusion, and glaucoma. In the context of uveitis, we believe that our results will further enhance the utility of these tools in the evaluation of eyes with uveitis using image thresholding algorithms.

The automated assessment of images obtained using the technology of OCT and OCTA can change the treatment paradigms in well-known uveitic conditions. For instance, demonstration of better recovery of retinochoroidal vessels following intravitreal injections compared to oral treatment can influence treatment decisions in the future. There can be an increased role of personalized medicine and precision medicine which may be guided by imaging-based and evidence-based analysis. Thus, we can imagine a future where a patient with an ocular inflammatory disease will undergo rapid non-invasive imaging in the clinic and will have an array of quantification done non-invasively. Thereafter, technological advances can enable us to narrow down to a handful of most likely diagnoses and decide the most appropriate therapy for the patient.

With an improved understanding of uveitic diseases, harnessing technological advances can potentially improve the quality of lives of our patients and ensure better outcomes. These tools can help increase the number of correct clinical decisions and minimize errors in treatments and delays in the diagnosis.