# Innovations in the diagnosis of ocular tumours

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Ocular tumours can vary widely in origin, from benign growths to metastases from distant disseminated malignancies. Although rare, ocular tumours pose a significant health and economic burden globally, with ocular cancers accounting for 0.2% of all diagnosed malignancies in the Western world [1]. Early identification is crucial in determining the treatment course, and can substantially improve the likelihood of positive patient outcomes through the timely administration of combination therapies. The advent of novel imaging techniques and technological advancements has revolutionised how ocular tumours are detected and classified. This article aims to highlight five key breakthroughs that have had a major influence on the diagnosis of ocular tumours.

## 1. Optical coherence tomography angiography

Optical coherence tomography angiography (OCT-A) was first utilised in 2014 as a non-invasive imaging modality enabling visualisation of the retinal microvasculature without the need for a contrast dye injection. OCT-A utilises laser light reflectance to capture the movement of red blood cells, with multiple A-scans of vascular segments being captured over time to assess the change in flow [2]. The high-resolution imaging provided by OCT-A allows the detection of suspicious vascular patterns such as high-density, irregular vessels that may be attributed to ocular malignancies such as choroidal melanoma. Another significant benefit of the non-invasive nature of OCT-A is that it allows for regular scans to check for any malignant transformation, increasing the likelihood of an early diagnosis.

## 2. Ultrasound biomicroscopy

Ultrasound biomicroscopy (UBM) is an advanced imaging technique that uses higher-frequency ultrasound waves to produce a highly detailed cross-sectional view of the anterior segment. The key advantage of UBM is that it allows greater visualisation of structures in the anterior segment that are often obscured, including the iris, ciliary body, and anterior chamber angle. Furthermore, UBM's tissue penetration depth of 4–5mm enables greater resolution imaging of denser lesions that may be difficult to see on OCT [3], which may provide further information about the extent of intraocular invasion. Ultrasound biomicroscopy is particularly useful in the diagnosis of ocular surface tumours, as it allows significantly more posterior margin identification (90% in UBM, compared to 29% in anterior segment OCT) [4]. However, it is important to note that while OCT is non-contact, UBM requires a coupling medium for the transducer, and thus the eye must be submerged in a water bath.

## 3. Hybrid molecular and cellular imaging

Molecular imaging includes the use of positron emission tomography (PET), often in combination with imaging modalities such as magnetic resonance imaging or computed tomography. Positron emission tomography uses a radiolabelled glucose analogue such as 18F-fluorodeoxyglucose that highlights areas of high metabolic activity [5], such as primary ocular malignancies alongside their distant metastases. Molecular imaging is becoming increasingly important in ocular oncology, as it allows not only the visualisation of small tumours in anatomically complex orbital locations but also provides information on the metabolic intracellular patterns that may indicate prognosis. Furthermore, metabolic uptake from cancer cells may be identified before the tumour becomes visible on structural imaging, allowing prompt diagnosis and the initiation of early aggressive chemoradiotherapy. Hybrid molecular imaging is a vital approach in ocular malignancies with high metastasis rates, such as uveal melanoma, in which 50% of patients will develop liver metastases [6].

## 4. Liquid biopsy

Liquid biopsies are a non-invasive, novel diagnostic tool that involves the detection of multiple biomarkers including circulating tumour cells, circulating tumoural DNA and RNA, tumour-related exosomes and tumour-educated platelets [7]. The key benefit of liquid biopsies is their ability to provide genetic and prognostic information for ocular tumours that cannot undergo tissue biopsy due to their anatomical location and subsequent risk of damage to delicate intraocular structures. This modality is also dynamic in nature and can be used to monitor disease progression alongside response to treatment, in contrast to classic tissue biopsies which cannot be readily repeated. Liquid biopsies have shown promising results in the monitoring of retinoblastoma and uveal melanoma [8], however, there is still a lack of international consensus on the perfect biomarker.

## 5. Artificial intelligence and machine learning in ocular oncology

The rise of artificial intelligence (AI) is revolutionising the field of ocular oncology, with machine learning (ML) algorithms that may aid in the recognition of subtle imaging patterns that may precede the development of ocular tumours. Machine learning is a subset of AI that teaches the computer to learn from data and make predictions by analysing large data sets as opposed to following a set of predefined instructions. In the context of ocular oncology, ML algorithms are fed a range of information including ocular scans, patient demographics, and genetic information to highlight risks of a cancer developing or to predict the post-diagnosis timeline. Recently, Luo, et al. developed an ML model to predict the prognosis of uveal melanoma post-brachytherapy, with a 79.5% accuracy, 77.1% specificity, and 79.8% sensitivity in metastasis prediction [9]. The accuracy of ML models increases as the dataset increases, therefore despite being in the early stages, AI is set to enhance the clinical approach to ocular tumour diagnosis and has the potential to alter the course of personalised management plans for these patients.

## Conclusion

The approach to diagnosing ocular tumours is an ever-changing landscape, from well-established imaging modalities to increasingly specific genetic analysis, alongside prognosis-defining software. These advancements are making it possible to identify eye tumours sooner, which leads to prompt treatment that could delay the development of tumour-related vision loss and lengthen median overall survival durations. As these technologies continue to advance, diagnostic precision will increase and cancer-specific personalised management plans will aid in reducing the global burden of ocular tumours.

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