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Tel: 8629-82245172 8629-82210956 Email: ijopress@163.com

· Review Article ·

Artificial intelligence in the anterior segment of eye diseases

Yao-Hong Liu[1,3], *Lin-Yu Li*[1,3], *Si-Jia Liu*[2,3], *Li-Xiong Gao*[2,3], *Yong Tang*[4], *Zhao-Hui Li*[1,2,3], *Zi Ye*[1,2,3]

[1]School of Medicine, Nankai University, Tianjin 300071, China
[2]Medical School of Chinese PLA, Beijing 100039, China
[3]Department of Ophthalmology, Chinese PLA General Hospital, Beijing 100039, China
[4]Chinese PLA General Hospital Medicine Innovation Research Department, Beijing 100039, China
Co-first authors: Yao-Hong Liu and Lin-Yu Li
Correspondence to: Zhao-Hui Li and Zi Ye. 28 Fuxing Road, Haidian District, Beijing 100039, China. 13701239057@163.com; yeziclover@163.com
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Abstract
● Ophthalmology is a subject that highly depends on imaging examination. Artificial intelligence (AI) technology has great potential in medical imaging analysis, including image diagnosis, classification, grading, guiding treatment and evaluating prognosis. The combination of the two can realize mass screening of grass-roots eye health, making it possible to seek medical treatment in the mode of "first treatment at the grass-roots level, two-way referral, emergency and slow treatment, and linkage between the upper and lower levels". On the basis of summarizing the AI technology carried out by scholars and their teams all over the world in the field of ophthalmology, quite a lot of studies have confirmed that machine learning can assist in diagnosis, grading, providing optimal treatment plans and evaluating prognosis in corneal and conjunctival diseases, ametropia, lens diseases, glaucoma, iris diseases, *etc*. This paper systematically shows the application and progress of AI technology in common anterior segment ocular diseases, the current limitations, and prospects for the future.
● **KEYWORDS:** artificial intelligence; anterior segment ocular disease; ametropia; glaucoma
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INTRODUCTION

The eye is the only part of the body that can directly observe blood vessels and nerves *in vivo*. Many types of medical images about this part, such as fundus photography, optical coherence tomography (OCT), slit lamp photography and so on, have the advantages of non-invasive and economical. Therefore, ophthalmology is a subject that highly depends on imaging examination, and the diagnosis of many eye diseases depends to a large extent on the results of imaging examination. At present, artificial intelligence (AI) technology is mainly used in medical imaging analysis, including automatic detection of disease occurrence, screening, diagnosis and grading, treatment guidance, quantification of treatment effect and identification of new treatment methods. Thus it can be seen that the combination of AI and ophthalmology has a great application prospect, and the development of ophthalmic AI is of great significance to realize the individual management of patients and to carry out large-scale eye health screening in different age groups.

WHAT IS ARTIFICIAL INTELLIGENCE?

AI is a new technology to develop theories, methods and technologies used to simulate and expand human intelligence. Machine learning (ML) is one of the research directions in this field, which aims to make computer systems extract generalized rules from data by algorithms characterized by "learning". We can categorize ML into two main types: conventional machine learning (CML) and deep learning (DL). CML models, like support vector machines (SVM), random forests (RF), decision trees (DT), linear regression, and logistic regression, are often used for tasks like disease diagnosis or classification using medical records or population data. These models don't typically involve complex neural networks. On the other hand, DL is more commonly applied to multimedia data such as images, sound, and videos. DL utilizes large neural networks like artificial neural network (ANN), recurrent neural network (RNN), and convolutional neural network (CNN) to analyze and process these types of data[1]. The basic concept of operation is that the engineer encodes the clinician's decision and cognition into a set of databases that can be executed by computer algorithms[2]. At present, image classification by DL is the most common application, such as distinguishing whether there is a disease or classifying the severity of the disease[3-4]. AI can also contribute to improving the methods of diagnosis and detection. The most important thing to evaluate AI system is the accuracy of the model, which is usually described by data such as area under curve (AUC), sensitivity and specificity.

The current research[5] showed that in order to make full use of the complementarity of different modal images, it was necessary to shift from single-modal DL to multimodal DL, which means that the results of different types of imaging examinations were used as training sets to improve the accuracy of AI in the diagnosis. A work reported by Peking Union Medical College Hospital at the meeting of the International Association for Vision and Ophthalmology Research in 2021[6] showed that the multimodal DL model with color fundus photograph and OCT image sequences as input can be used to detect a variety of common ocular fundus diseases that cause blindness.

ANTERIOR SEGMENT DISEASES & ARTIFICIAL INTELLIGENCE

Anterior segment diseases refer to pathologies affecting the eyelids, conjunctiva, cornea, anterior chamber, iris and lens. These diseases can be caused by various factors, including infections, autoimmune diseases, trauma, *etc*. Early detection and appropriate management are crucial in controlling disease progression and optimizing treatment outcomes for anterior segment disorders.

Although application of AI in anterior segment diseases is later than that in fundus diseases, quite a lot of studies had confirmed that ML can assist in diagnosis, grading, providing optimal treatment plans and evaluating prognosis in corneal and conjunctival diseases, ametropia, lens diseases, glaucoma, iris diseases, *etc*. The accuracy of some of them can be comparable to the level of ophthalmologists. We will introduce the latest research and application of ML in different kinds of diseases mentioned above.

Application of Artificial Intelligence in Corneal Diseases

Corneal diseases frequently result in vision impairment, causing symptoms such as blurred vision, reduced visual acuity, and in severe cases, blindness. At present, it is known that ML models using the slit lamp photography, corneal topography, anterior segment optical coherence tomography (AS-OCT) and corneal confocal microscope examination are able to complete the detection of keratoconus, preoperative screening of postoperative dilatation risk, diagnosis of infectious keratitis, prediction of complications after keratoplasty and so on[7].

Keratoconus Keratoconus is a non-inflammatory asymmetrical progressive dilated eye disease of bilateral cornea, which can lead to irregular astigmatism and high myopia, resulting in serious visual impairment. Lavric and Valentin[8] reported a CNN method called "KeratoDetect" for detecting keratoconus. The 3000 corneal topographic maps (half from healthy eyes and the other half from eyes diagnosed with keratoconus) were used for training. The verification set was 150 eyes, and the accuracy of the test set on 200 eyes was 99.3%. Kamiya *et al*[9] obtained a six-color coding map with the method of AS-OCT, which can be used to distinguish keratoconus from normal cornea and to grade the severity of the disease. In the treatment of keratoconus, Lyra *et al*[10] established a computer model based on ML and corneal tomographic data to predict the asphericity and average corneal thickness after intrastromal corneal ring segments (ICRS), which is helpful to make a better surgical plan to improve the prognosis. Different types of corneal rings have different thickness, diameter and profile. ICRS can be perfectly designed for patients according to ametropia, corneal thickness and corneal curvature.

Infectious keratitis Infectious keratitis is a corneal disease that occurs in a short time and progresses rapidly and may cause corneal perforation and intraocular infection. It is the primary cause of corneal blindness globally[11]. The staining and culture of corneal scraping under microscope is the gold standard for determining the pathogenic microorganisms of infectious keratitis.

Kuo *et al*[12] effectively created a DL-based model for corneal photograph analysis, achieving an average accuracy of 70% in detecting fungal keratitis. This performance was similar to that of non-corneal specialist ophthalmologists. Zhang *et al*[13] employed model blending technology to create KeratitisNet, showcasing the highest average accuracy among various model development approaches. Hung *et al*[14] created DL models to distinguish between bacterial keratitis and fungal keratitis, achieving a maximum average accuracy of 80.0% with slit-lamp images obtained from 580 patients. In the study by Ghosh *et al*[15], CNN models were assessed for the ability to rapidly differentiate between fungal keratitis and bacterial keratitis. The top-performing model achieved an AUC of 0.86 using slit-lamp images from 194 patients. In another study conducted by Li *et al*[16], smartphone macro corneal photography was incorporated as a dataset. Surprisingly, this approach yielded promising results, with the top-performing algorithm achieving an AUC of 0.967 in detecting keratitis.

Keratoplasty AI also has related research and application in keratoplasty. Using a DL-based classifier, Treder *et al*[17] reported a reliable automatic detection of keratograft dislocation in descemet membrane endothelial keratoplasty using a training set consisting of 1172 AS-OCT images (609 attached keratografts and 563 separate keratografts). Through the test set consisting of 100 AS-OCT images, the sensitivity of the classifier is up to 98%, the specificity is 94%, and the accuracy is 96%. Hayashi *et al*[18] established a VGG19 model, which used the rebubbling standard that keratograft detachment reached the central pupil region within 4.0 mm to determine whether anterior chamber needed to be bubbled again after descemet membrane endothelial keratoplasty. The AUC, sensitivity and specificity of the model are 0.96, 96.7%, and 91.5%, respectively.

Application of Artificial Intelligence in Conjunctival Diseases

Pterygium Pterygium is a kind of fibrovascular tissue which originates from the conjunctiva and even spreads over the limbus. When pterygium grows to cover the iris and pupil area, it can lead to visual impairment. Due to uneven and irregular corneal curvature, corneal deformation caused by pterygium may lead to astigmatism. In the clinical process, the identification and diagnosis of pterygium usually requires to be stained by fluorescein in order to highlight the pterygium tissue, which is kind of invasive because it needs to drip fluorescein onto the surface of the eyeball. Gao *et al*[19] proposed a cortical cataract automatic grading system using an image processing algorithm for pterygium detection. They used color information to detect if there is pterygium in the sclera and pupil areas. Mesquita and Figueiredo[20] used ML to segment iris and the region growth algorithm to detect the progress of pterygium tissue. Wan Zaka *et al*[21] proposed a pterygium screening system by analyzing corneal morphologic features obtained from anterior segment images taken by smart phones. The systems above are mainly used to distinguish pterygium from normal cornea, and the prospective application of AI in pterygium can be the development of automatic pterygium grading system.

Trachoma Despite considerable advancements in disease control efforts, trachoma remains the primary infectious cause of blindness worldwide. Socia *et al*[22] utilized a dataset comprising 2300 images, with a 5% positivity rate for trachomatous inflammation follicular. They constructed classifiers by employing two cutting-edge CNN architectures, ResNet101 and VGG16, and utilized various data augmentation and oversampling techniques on positive images. The top-performing models achieved a sensitivity of 95% and a positive predictive value ranging from 50% to 70%.

Application of Artificial Intelligence in Dry Eye Disease Dry eye disease (DED) is a prevalent ocular condition affecting 10%–40% of the global population. It is characterized by disturbances in tear film composition, including hyperosmolarity and tear film instability, leading to multifactorial ocular surface issues[23].

Llorens-Quintana *et al*[24] devised a novel algorithm for automatically detecting the meibomian gland (MG) area and objectively analyzing the morphological characteristics of it. Wang *et al*[25] introduced a DL model built upon VGGNet-13 for automatically detecting lid margin abnormalities, which could indicate DED, in anterior segment photographs. Saha *et al*[26] introduced a classification-focused DL model for swift, automated, and unbiased assessment of MG morphological characteristics. This model encompasses MG segmentation, quantitative analysis of MG area and ratio, and determination of the meiboscore. It achieved accuracies of 73.01% and 59.17% for meiboscore classification on the validation set and images from independent centers, respectively. da Cruz *et al*[27] introduced an ML approach for classifying tear interferometry images, employing texture analysis with phylogenetic diversity indices. The RF classifier exhibited the most favorable outcomes, achieving an accuracy surpassing 97% and an AUC of 0.99.

Application of Artificial Intelligence in Ametropia

Ametropia, such as hyperopia, myopia, and astigmatism, are prevalent eye conditions. In China, the increasing prevalence of myopia in children has emerged as a significant societal concern.

Barraza-Bernal *et al*'s[28] research utilized population-based data from Chinese children to create an ML algorithm for assessing the risk of myopia onset and progression. The most effective algorithm emerged from a blend of support vector regression and Gaussian process regression. In Lin *et al*'s[29] research, the RF model can forecast the onset of high myopia by the age of 18 as early as 8y beforehand, achieving clinically acceptable accuracy through long-term refraction data. In addition, instead of relying on mydriatic optometry, utilizing SVM and gradient boosting regression tree for a comprehensive evaluation of axial length elongation, a crucial marker for high myopia, can effectively predict myopia progression[30]. Foo *et al*[31] created a DL system to identify children at risk of developing high myopia. The results indicated that their system achieved high accuracy, with all AUC scores surpassing 0.90.

Refractive surgery can be divided into corneal and intraocular refractive surgery. Yoo *et al*[32] devised an ML model, employing a multiclass eXtreme Gradient Boosting approach, to determine the most suitable refractive surgery for adult patients with myopia.

AI-supported contact lens therapy is gaining traction. Fan *et al*[33] developed an ML model utilizing various algorithms including linear regression, SVM, Bagged Trees and Gaussian processes to forecast the curvature of orthokeratology lenses. This predictive model reduces the need for multiple lens trials, enhancing efficiency and accuracy while lowering the risk of cross-infection associated with trial lenses.

Application of Artificial Intelligence in Lens Diseases

Cataract is currently the leading cause of visual impairment and blindness worldwide. The early diagnosis of cataract is of great significance to the prevention of cataract-related complications, the choice of surgical methods and the recovery of postoperative visual acuity. In the case of relatively unbalanced medical resources, the early screening of cataract patients by AI can avoid delaying the disease, and urge them to see a doctor and receive treatment in time. As a result, it can reduce the rate of blindness or visual impairment caused by the disease.

Age-related cataract Age-related cataract is the predominant form of cataract. It primarily results from the progressive opacification of the lens due to aging, leading to vision impairment. The prevalence of it escalates with advancing age. Wu *et al*[34] established and verified a DL algorithm ResNet, which can distinguish cataract, intraocular lens (IOL) and normal lens by recognizing slit lamp images accurately (AUC>0.99). In the meantime, it has great potential in grading and classifying cataracts. Xu *et al*[35] developed a CNN-based integration algorithm (AlexNet and VisualDN), which uses 8030 fundus images to diagnose and grade cataracts with high precision (86.2%). Keenan *et al*[36] developed DeepLensNet, which conducted automated and quantitative classification of cataract severity across all three age-related cataract types. It demonstrated notably higher accuracy compared to ophthalmologists for the two prevalent types (nuclear sclerosis and cortical lens opacity), while showing comparable performance for the less common type (posterior subcapsular cataract).

In terms of evaluating prognosis, AI has also been developed. The AI system built by Mohammadi *et al*[37] using ANN can predict the risk of posterior capsular opacification in patients after phacoemulsification. Jiang *et al*[38] proposed TempSeq-Net, a DL algorithm based on slit lamp images, which can predict the need of YAG laser capsulotomy during a 2-year follow-up in patients after phacoemulsification, with an accuracy of 92.2%.

Congenital cataract Congenital cataract is the leading cause of reversible blindness in childhood. Treating these children necessitates specialized surgical procedures and follow-up.

In addition to age-related cataracts, AI screening for congenital cataracts have also been reported in recent years, such as the intelligent localization diagnosis framework for congenital cataracts developed by Liu *et al*[39] using CNN, SVM and other tools. A high-precision AI software that can diagnose, grade and provide treatment advice for children suffering from cataracts with sensitivity of 90% and specificity of 86% trained by Lin *et al*[40]. The AI diagnosis platform for congenital cataract based on cloud computing developed by Long *et al*[41].

Intraocular lens formula Not only in diagnosis, but also in cataract surgery, AI may help to improve the performance of IOL formulas. With the increasing demand for visual acuity after cataract surgery, a generally accepted goal of postoperative refractive state is within 0.50 D of emmetropia or mild myopia. AI can provide an improved framework for optimizing IOL calculation formulas, which is more accurate and customized for specific cataract surgeons. A recent small-scale study using AI-hybrid formulas significantly improved the results supplied by a surgeon. the proportion of postoperative diopter less than 0.50 D of predicted diopter increased from 76% (using standard super formula) to 80% (using super formula assisted by AI algorithm). By learning from the parameters, AI can highlight those "high-risk" eyes with ametropia before operation[42]. Sramka *et al*[43] proposed that ML achieved significantly better results in IOL calculation (82.3%–82.7% within 0.50 D) than traditional clinical methods (57.7% within 0.50 D) by using SVM regression model and multilayer neural network integrated model, which is considered to be one of the most accurate formulas for IOL calculation, thus optimizing refractive results. It reduces the need for reoperation after cataract surgery.

At present, the AI-assisted IOL calculation formulas that have been published include Kane, Hill-RBF calculator, Pearl-DGS, FullMonte IOL software system, Ladas Super Formula AI, *etc*[44]. When using the same formula across various axial length subgroups, varying outcomes were noted. The Pearl-DGS formula yielded the smallest mean absolute error, while the RBF 2.0 formula exhibited the poorest performance in shorter eyes. Conversely, the Kane formula achieved the lowest mean absolute error in both medium and long eyes[45].

Application of Artificial Intelligence in Glaucoma

Glaucoma encompasses open angle and closed-angle types, both marked by sustained elevated intraocular pressure, resulting in damage to ocular structures and visual function. Untreated, it can progress to complete visual field loss and eventual blindness. The clinical classification of glaucoma depends on the degree of anterior chamber angle closure, the reference clinical standard for whose evaluation is gonioscopy. However, this technique is very subjective and not always repeatable. With the development of imaging technology like AS-OCT, direct and non-contact anterior chamber angle imaging becomes possible[7].

ResNet stood out as the most favored pretrained CNN in glaucoma researches, consistently delivering superior accuracy compared to other CNN models[46].

Kazemian *et al*[47] developed a new glaucoma prediction tool that can predict the degree of progression in patients with open-angle glaucoma at different levels of intraocular pressure. Based on the optic disc and retinal region's image feature model, Haleem *et al*[48] proposed an automatic glaucoma detection method, which can realize the automatic location and segmentation of optic disc and screen glaucoma according to the characteristics of different regions of the image, with an accuracy of 94.4%. Li *et al*[49] built an AI model named DiagnoseNet to differentiate color fundus photographs between glaucoma and non-glaucoma. Subsequently, they devised a pipeline called PredictNet to forecast the onset and progression of glaucoma. The AI model for predicting glaucoma incidence and progression achieved the AUC of 0.90 and 0.91 in the validation set.

de Vente *et al*[50] proposed the "Artificial Intelligence for Robust Glaucoma Screening" challenge aimed at developing AI algorithms for reliable glaucoma screening. The challenge included a vast dataset comprising approximately 113 000 images from 60 000 patients across 500 screening centers. Emphasizing robustness to diverse and unexpected input data, 14 teams participated, with top-performing teams matching the diagnostic accuracy of 20 expert ophthalmologists and optometrists. The leading team achieved an impressive AUC of 0.99 for real-time detection of ungradable images.

In the treatment of glaucoma, Koh *et al*[51] developed an automated algorithm to predict the success rate of laser peripheral iridotomy using AS-OCT for primary angle-closure glaucoma with an accuracy of 89.7%, a specificity of 95.2%, and a sensitivity of 36.4%. Banna *et al*[52] carried out the initial study to utilize ML for predicting trabeculectomy outcomes. RF emerged as the top-performing model, achieving an accuracy of 0.68 and an AUC of 0.74 with 5-fold cross-validation. These findings suggest that ML hold promise in forecasting trabeculectomy outcomes for patients with refractory glaucoma. Agnifili *et al*[53] focused on using ML to predict the outcome of filtration surgery. The classification tree algorithm was employed for data analysis and it achieved an AUC of 0.784 (0.692–0.860). According to the classification tree analysis, a thicker and hyper-reflective stroma preoperatively, along with younger age, were associated with an increased risk of filtration surgery failure.

Application of Artificial Intelligence in Iris Diseases and Iris Biometric Detection Iris diseases primarily refer to abnormalities of the iris and its surrounding structures. Dimililer *et al*[54] proposed an intelligent ocular tumor detection system based on two traditional back-propagation neural networks, which could accurately detect different types of iris tumors with an accuracy of 95.7%. Another AI model[55], utilizing a K-means clustering approach, demonstrated perfect accuracy (100%) in automatically detecting iris tumors.

Iris biometric detection offers touchless authentication, leveraging the intricate texture and distinct characteristics of the iris for identification and authentication across various applications. Its procedure comprises three main stages: image preprocessing, feature extraction and matching identification. Nowadays, it's considered the most dependable and precise biometric identification AI system currently accessible[56].

There are relatively limited clinical studies on the application of AI in iris diseases compared with other anterior segment diseases. In fact, anterior segment photography of iris diseases can provide a basis for diagnosis and other abundant information for AI. It is believed that there will be more related studies in this field to explore the application value of AI in iris diseases.

TELEMEDICINE & ARTIFICIAL INTELLIGENCE

Telemedicine can provide a wealth of valuable data, such as real-time calculations of morbidity and disease progression in the real world. If applied correctly, the data collected will be incorporated into large databases that far exceed the data capture capabilities of most individual studies. In addition, the data will be valuable in the development of predictive capabilities for disease progression combined with AI.

Wu *et al*[34] introduced an AI-assisted telemedicine platform for the assessment and diagnosis of cataracts of varying severity in adults and children in the real world. Patients can be self-monitored at home by taking eye surface images using mobile phones, accompanied by a brief clinical history and vision condition. Then they will be arranged to community health facilities, where slit lamps are available and ophthalmic anterior segment images can be analysed by the DL system ResNet. If necessary, patients who have surgical indications will be given a referral to tertiary eye hospitals through the fast-track notification system. In addition, by integrating AI technologies, Ting *et al*[57-58] proposed that remote cataract screening workflows measured by the population ratio of ophthalmologists to patients could further improve productivity.

As the research progresses, more specialized eye images can also be taken with smartphones. For example, a smartphone attached to a slit-lamp could perform biometrical video imaging of the eye, allowing ophthalmologists to view a patient's ocular features in real time without the patient visiting the doctor[59]. Maamari *et al*[60] developed a new remote platform that uses a smartphone software to detect and diagnose corneal abrasions and ulcers. Consisting of a +25.0 D lens and a white and blue light emitting diode light source, it is specially designed to capture ophthalmic anterior segment images under a fluorescein staining test or not. The platform's performance in detecting corneal ulcers is excellent compared to the slit-lamp based assessment by ophthalmologists. A Japanese research team[61] invented a portable and recordable slit-lamp device, called "Smart Eye Camera". It's a mobile phone accessory that can take videos of the eye surface, and it can also convert the light source of the smartphone to cobalt blue light and record the stained eye surface. At the same time, the diagnosis system of DED was developed by the research team using DL model. This model has high sensitivity (0.778), specificity (0.857) and AUC (0.813) for the diagnosis of DED. Shimizu *et al*[62] introduced an AI system for cataract diagnosis trained with ML algorithms and video recordings obtained through a portable slit-lamp device. This system demonstrated excellent sensitivity and specificity for diagnosing cataracts and estimating nuclear cataract grade. The model's performance closely resembled that of ophthalmologists. In the application of glaucoma, Wu *et al*[63] developed a smart phone tonometer combined with AI algorithm, whose prototype is an attachment fixed to the phone, falling into line with camera and flashlight. When measuring the intraocular pressure, the transparent block at its head will temporarily oppress the eye surface to produce an instantaneous flattening circle. The task of the ML algorithm is to detect the contact area and collapse depth of the eyeball caused by the tonometer in each frame of the video recorded by the smartphone, so as to calculate the intraocular pressure.

LIMITATION

At present, the sample sizes of training sets and verification sets of most ML methods are too small. In addition, there are still a relatively limited number of standardized data sets at home and abroad, so each team tends to use their own data sets, with different interpretability and reliability. In addition, because it is difficult to implement unified and standardized inspection equipment in different places, the image results obtained by different equipment are different in terms of color and resolution, thus affecting the accuracy of diagnosis. Therefore, validating algorithms externally encounters several obstacles. Their effectiveness may diminish in real-world clinical settings due to variations in image quality, imaging devices, and patient compliance, highlighting the need for enhancements in these aspects. The pixel regions of the images that AI observes and learns are not always consistent with those clinicians usually use to identify disease characteristics. If a small pixel disturbance is carried out on the image, the judgment provided by AI might be interfered with in the meantime[64]. Another aspect affecting the recognition of clinicians is that AI still lacks the ability to explain and generalize the diagnosis of diseases[65], and is also unable to diagnose rare diseases. Therefore, optimizing algorithm and resolution of images, expanding sample content and enriching subjects' type are powerful means to break the limitations.

SUMMARY & PROSPECT

With the popularity of AI technology in the field of ophthalmology, many computer programs and devices came into being, such as digital slit lamp combined with AI technology, automatic multifunctional comprehensive ophthalmoscope, which built a health screening net outside the hospital for screening anterior segment diseases, and made up for the shortage of professional ophthalmologists in basic-level eye health management institutions. AI algorithms for clinical use need to be personalized and contextualized. The incorporation of clinical histories and data (*e.g.*, presence and duration of visual symptoms, associated risk factors and vision) into image-based AI algorithms, which should be called multi-modal DL[66], can improve the accuracy of AI as a substitute for diagnosis and referral by human beings[57]. Multi-modal ML can be used to assess whether the diagnostic or predictive capabilities of an AI algorithm will increase with the addition of more imaging modes[59]. Although the application of AI in anterior segment diseases is later than that in fundus diseases, the relatively abundant examination types of anterior segment diseases are advantageous for the development of multi-modal AI. Additionally, in recent years, most anterior segment diseases can be remotely diagnosed and treated through smartphone software assisted by AI, which is highly beneficial for early diagnosis.

"Foreseeing the future" is another research hotspot in the development of AI technology in ophthalmology. AI can be used to predict treatment response, optimal treatment interval and future disease progression in advance, thus making individualized prognostic intervention possible. While existing digital technologies focus on diagnosis, future AI will play a more and more important role in directing treatment[59]. At the same time, AI can provide valuable insights into the pathophysiological characteristics and mechanism of the disease by analyzing the microstructure characteristics of the disease model available, and open up new horizons.

In terms of treatment, with the growing range of surgical choices in anterior segment disease treatment, predictive models can enhance patient care and assist in making surgical decisions. At the same time, with the introduction of intelligent sensors into the intraocular surgical robot system, it is likely that certain procedure steps in ocular operations will evolve from robot-assisted to semi-autonomous operations one day in the future[67].

Although AI faces many medical challenges, with the joint efforts and participation of medical experts, image processing experts, and software developers, the shortcomings will eventually be solved, ushering in further changes and breakthroughs.

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