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Review of eye diagnosis in traditional Chinese medicine: Modernization and future prospects

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ABSTRACT

This article reviews the basic theories, methods, and clinical applications of eye diagnosis in traditional Chinese medicine (TCM). It introduces cutting-edge methods and applications and explains that the modernization of TCM eye diagnosis includes “equipment-assisted diagnosis” and “artificial intelligence-based diagnosis”. The article also notes that while there are many recent studies of the static attributes of eyes in modern TCM eye diagnosis, modern application research on the dynamic attributes of eyes in TCM diagnosis theory is relatively rare. We propose, therefore, that introducing advanced eye-movement detection technology into TCM clinical diagnosis could help to further modernize TCM eye diagnosis.

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1. Theory and application of eye diagnosis in traditional Chinese medicine (TCM)

1.1. Theoretical origin of eye diagnosis in TCM

In clinical traditional Chinese medicine (TCM), “diagnosis” and

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“treatment” are indispensable, among which “diagnosis” is the premise and is particularly important. According to *Wang Zhen Zun Jing*, “if one wants to treat it, one must diagnose it; if one does not diagnose it, one cannot know the disease; and if one does not diagnose it, one cannot establish the treatment”.¹ Among the 4 diagnostic methods of TCM (inspection, auscultation and olfaction, inquiry and pulse-feeling, and palpation), inspection is the primary stage. Physicians can obtain the physiological and pathological state of patients by means of a purposeful observation of spirit, shape, color, state, and excrement. TCM inspection, from the whole body to local parts, is rich in its content.² Eye diagnosis belongs to the category of local-parts inspection in TCM. The first record of TCM eye diagnosis is found in *Spiritual Pivot (Ling Shu)*. “The Jingqi (essence-qi) of the five *zang*-organs and the six *fu*-organs all flow upwards into the eyes to enable the eyes to see.”³ TCM eye diagnosis is an adjunct method of diagnosing diseases by observing the eyes. Physicians can judge the condition of viscera and identify the location and nature of lesions by looking at the expression, color, shape, and state of the eyes. The eyes can also indicate the progress of disease and reflect the mechanism of lesions. As the main part of TCM inspection, eye diagnosis plays a very important role and has many advantages.⁴

The eyes can be regarded as the exposed *zang*-organs of the human body. The essence and qi of the *zang*-organs communicate with the eyes, forming the embryonic form of the five-wheel theory. Five-wheel theory has been historically important for distinguishing diseases and patterns.^{5,6} According to five-wheel theory, the eye is divided into 5 parts: eyelids, inner and outer canthus, white of the eye, iris, and pupil. These 5 parts are referred to as the meat wheel, blood wheel, qi wheel, wind wheel, and water wheel, corresponding to spleen, heart, lung, liver, and kidney, respectively.⁷ As noted in the *Shen Shi Yao Han*, “the eyes have wheels, and each eye wheel connects to an organ; the dysfunction would be inevitably reflected in the corresponding wheel; liver disease is reflected in the wind wheel; lung disease is reflected in the qi wheel; heart disease is reflected in the blood wheel; kidney disease is reflected in the water wheel; and spleen disease is reflected in the meat wheel.”⁸ According to changes in the five wheels, physicians can determine visceral lesions and then select a prescription for treatment.⁹ If the expression of the eyes is bright and their dynamic state is flexible, viscera are not weakened, and the patient is either not ill or only mildly ill. The physiological and pathological state of the body is reflected not only in the static color and shape attributes of the eyes, but also in dynamic movement attributes. In addition to looking at static color, shape, or blood distribution, physicians should pay attention to dynamic movement, stability, fixation, and other eye characteristics.¹⁰

1.2. Clinical application of TCM eye diagnosis

1.2.1. Observing the static characteristics of eyes for diagnosis

Physicians diagnose patterns through changes in the static features of eyes or eye lesions. The static features of eyes mainly include color and shape.¹¹ According to the *Plain Conversation (Su Wen)*, all 5 colors indicate different degrees of cold and heat, in which yellow and red indicate heat, and white indicates cold.¹² In clinical processes, therefore, physicians can distinguish a deficiency or excess of cold or heat in relation to disease based on eye color. If a patient's eyes have a yellowish color, such as orange, the pattern type is most likely a damp-heat accumulation pattern. If a patient's eyes are dull yellow, the patient most likely suffers from cold-dampness repression. Zhang Zhongjing also used eye color to understand disease mechanisms.¹³ Taking ocular red (conjunctival congestion) as an example, cold-evil closes the muscle surface and the three yang meridians, leading to an excess of pathogenic heat;

or, evil invades Shaoyang, leading to liver-fire flaming, or evil accumulates in the blood.¹⁴ Preliminary eye diagnosis can help physicians to accurately understand the mechanism of disease and thus improve diagnosis. Gan noted that more than 66.5% of patients with primary nephrotic syndrome had typical changes in the color and shape of white-eye collaterals, as well as black eyes.¹⁵ Such changes, having a certain correlation with TCM pattern types, can be used as observation indicators to guide clinical practice. Inspecting the eyes of patients with liver-kidney yin deficiency pattern, Liu found that the color of the white-eye collaterals was mostly dark red, and the shape of the white-eye collaterals was different in thickness with unclear boundaries. Such characteristic changes in the white-eye collaterals can be used to identify patterns.¹⁶

The diagnosis of eye shape is based on inspecting the shape lesions of the orbits, upper and lower eyelids, eyeballs, blood collaterals, pupils, and so on. Pathological changes in viscera can be reflected in the shape of the eyes. Chu et al suggested that liver disease can lead to various eye changes, such as conjunctive congestion with swelling and pain, and fundus vascular changes.¹⁷ If the spleen-qi is deficient, the eyelid cannot be filled and nourished or freely opened and closed.¹⁸ If eyelid edema is observed, and water stops at the skin, it is mostly attributable to dysfunctions of the lung, spleen, or kidney. Therefore, through changes in eye shape, physicians can identify pathological changes in viscera, which can provide a basis for identifying the location and characteristics of a disease. In addition, a physician's grasp of morphological changes in the eyes is conducive to improving the effects of clinical treatment. Ma found that herpes zoster in the eyes mostly corresponded to liver-gallbladder hyperthermia or liver-gallbladder damp-heat inflammation. A treatment scheme that involves clearing away liver and gallbladder heat can improve the treatment of herpes zoster.¹⁹ Gu et al reported that the abnormal shape of the wind wheel increased with the stagnation of liver-qi pattern. Thus, observing morphological changes can help improve the treatment of patients with the stagnation of liver-qi pattern.²⁰

1.2.2. Observing the dynamic attributes of eyes for diagnosis

The observation of dynamic changes in the eyes is key to treatment and prognosis. Many physicians distinguish the tendency and determine the mechanism of disease through abnormal changes in eye state. Thus, considerable importance is attached to the diagnosis of dynamic eye characteristics. According to *Spiritual Pivot (Ling Shu)*, the Jingqi (essence-qi) of the five *zang*-organs is the material basis of spirit activity. when the Jingqi (essence-qi) are exhausted, there will be critical symptoms such as the rotation of the eye system collaterals, blurred vision and coma.³ Hence, this abnormal movement of the eyes could indicate the spirit state, and then reflect the overall health status of the patient. Zhang Zhongjing described dynamic changes in the eyes in the pattern of Da Chengqi decoction. The accumulation of heat in the *fu*-organs leads to excessive damage to yin and yang, blurred vision, and inflexible eye movement. Eye movement is further changed with the aggravation and transmission of heat accumulation.¹³ Based on changes in eye movement, we can differentiate the yin injury caused by heat accumulation and the degree of six meridian transmission.²¹ According to TCM theory, when lesions in the Kidney meridian of foot-shaoyin and Liver meridian of foot-jueyin spread to the liver, they can lead to eye closure, laziness, and eye-movement retardation.¹² This type of eye movement can also occur in another situation. Zhang Zhongjing found that under some externally contracted disease, herbal medicine could help to tonify healthy qi. The tonified healthy qi can be strong enough to deal with pathogenic qi, thereby resulting in photophobia with closed eyes.¹³ Such closed eyes suggest a proper treatment plan.²² Dynamic eye changes can not only guide clinical treatment but also be

used to judge the severity and prognosis of disease. On the basis of the records of *Spiritual Pivot (Ling Shu)*, qi deficiency in Taiyang will lead to glaring and looking up, indicating a poor prognosis.³ *Treatise on Febrile Diseases* refers many times to dynamic pathological changes in direct vision.¹³ Direct vision refers to seeing things without turning. If direct vision and emotional abnormalities occur at the same time, the pathogenesis can be judged as a deficiency of fluid and blood or a deficiency of yin owing to heat burning, indicating an acute or critical condition.²³ The physiological and pathological state of the body is closely related to dynamic changes in the eyes. When diagnosing and treating diseases, physicians should pay considerable attention to the dynamic features of the eyes.

2. Applying modern techniques to TCM eye diagnosis

TCM eye diagnosis is increasingly valued for its simplicity, intuitiveness, and effectiveness. For a long time, physicians have provided subjective and qualitative diagnoses and treatment plans based on inspecting a patient's eyes. However, physicians' diagnostic abilities, interference from the environment, and a limited observation range can affect the results of diagnosis. These unfavorable factors can hinder the development of TCM eye diagnosis. It is critical, therefore, to find new technologies and methods for TCM eye diagnosis that could help physicians standardize information about the 4 diagnostic methods and improve the accuracy of pattern differentiation and treatment. At present, the modern technologies used in TCM eye diagnosis mainly fall under 2 categories. The first is "equipment-assisted diagnosis". In this category, physicians use western ophthalmic diagnostic equipment to identify structural or pathological changes in the eyes that cannot be observed by the naked eye, and they make diagnoses based on their clinical experience. The second is "artificial intelligence-based diagnosis". In this category, modern instruments are used to collect static images of the eyes. Then, digital image-processing technology and artificial intelligence (AI) algorithms are combined with TCM eye diagnosis theory to build an algorithmic model and identify the relationships between eye color, shape, and disease, which are ultimately applied to clinical diagnosis.

2.1. Equipment-assisted diagnosis

Ophthalmic examination equipment opens up new development direction for TCM eye diagnosis. Using various types of equipment and processes, such as slit-lamp biomicroscopy, ultrasound biomicroscopy, fluorescein fundus angiography, and optical coherence tomography, physicians can observe deeper anatomical structures and combine the results with the whole-body syndromes obtained from the 4 diagnostic methods for pattern differentiation and treatment.²⁴ This can improve the accuracy of clinical diagnosis and treatment.²⁵ Jiang et al examined conditions such as a sharp decline in vision, congestion and edema of the optic papilla, and fundus retinal varices using modern ophthalmic instruments. Combining those results with conditions such as insomnia, fever, thirst, red tongue with yellow fur, and other systemic symptoms, they obtained the TCM pattern types of fundus collateral disease by analyzing the location and nature of disease.²⁶ Peng et al, meanwhile, established diagnosis and treatment that connected morphological changes in fundus vessels to specific TCM patterns, such as blood stasis, phlegm-dampness, hyperactivity of liver-fire, liver-kidney yin deficiency, qi stagnation, and deficiency of qi and blood.²⁷ Morphological changes in fundus vessels correspond to many systemic diseases; in particular, they have important reference value for the diagnosis of hypertension, diabetes, and

other diseases.^{28–34} Therefore, the micromechanisms of pathological eye changes can be used as an important index for evaluating TCM pattern types.

2.2. AI-based diagnosis

Modern ophthalmic detection technologies can help physicians find lesions that are difficult to detect by the naked eye. However, physicians must manually diagnose these lesions. With the development of digital image processing and AI analysis technology, TCM eye diagnosis has been able to transit from equipment-assisted diagnosis to AI-based diagnosis.³⁵ First, static images of the eyes are collected using special equipment. Then, AI marks the related morphological and color characteristics. Finally, using an AI algorithm, a model is constructed to establish correlations between static eye characteristics and systemic diseases.³⁶ At present, intelligent diagnostic methods based on iris images are widely used in clinical contexts. Iris diagnosis is based on combining the pathological characteristics of the iris, TCM eye diagnosis theory, clinical diagnosis and treatment experience, and AI.³⁷ Yang et al analyzed the iris images of 350 patients and combined their iris images with diagnostic TCM theories to summarize the characteristic abnormalities in the iris and the possible corresponding diseases.³⁸ For example, black dots are often associated with cardiovascular diseases such as coronary heart disease and rheumatic heart disease while black light, defect, pallor, fovea, convoluted whorl, shrinking, and white zone correspond to chronic nephritis, craniocerebral trauma, acute inflammation, chronic anemia, abdominal inflammation, mental stress, and cerebral arterial insufficiency, respectively. In this way, a correlation model was established between iris image features and diseases. This correlation model can provide an important basis for diagnosing disease and pattern types while also potentially forming a new TCM eye diagnosis method with systematic theoretical and clinical support. In the clinical context, modern AI-based diagnostic methods can be used to explore the potential value of the characteristics of various eye regions, providing support for early diagnosis and intervention against disease.

3. Limitations and prospects of modernized TCM eye diagnosis

TCM eye diagnosis has achieved breakthroughs in the recognition of static features such as eye color and shape through the use of microscopes, imaging equipment, intelligent algorithms, and other technologies.²⁵ TCM physicians currently infer the health or disease state of the five *zang*-organs and six *fu*-organs by examining the static attributes of eyes while ignoring important dynamic attributes.

Although the dynamic attributes of eyes have long existed as parameters in descriptions of TCM disease diagnosis, there has been no in-depth research on TCM eye diagnosis. By contrast, in Western medicine research and clinical practice, especially in fields related to brain science, neuroscience, and psychology, there have been numerous studies of the relationship between eye movement and physical and mental health.^{39–44} Commonly used technologies for eye-movement detection include electro-oculogram and pupil-corneal reflection techniques.^{45–50} Electro-oculogram technology has been applied to many fields, such as human–computer interaction, psychology, medical diagnosis, communication schemes for patients with motor neuron diseases, and sleep-state research (Fig. 1).^{51–54} The pupil-corneal reflection technique allows for accurate, sensitive, and noninvasive eye-movement detection and is widely used in research on cognition,^{55,56} memory,⁵⁷ attention,^{58,59}

reading,⁶⁰ visual-spatial judgment,⁶¹ and emotional processing,⁶² among other fields (Fig. 2).

Mental activity is most easily observed via the eyes.²³ In the future, the modernization of TCM eye diagnosis could focus on utilizing the methods and strategies of eye-movement detection in clinical medicine and psychology, combining basic TCM theory and modern equipment to help capture dynamic eye-character information.

4. Conclusion

Eye diagnosis is an important method of differentiation in TCM and has long been recognized by TCM practitioners. With the development of modern technology, new technologies have been adopted to promote the more objective and digital development of TCM eye diagnosis. Existing research has introduced western ophthalmic diagnostic equipment, image recognition technology, data analysis, and other technical means into TCM eye diagnosis, forming 2 categories, equipment-assisted diagnosis and AI-based diagnosis. At the same time, the introduction of eye-movement detection technology could enhance TCM eye diagnosis and form a new method of TCM disease diagnosis based on eye-movement data.



Fig. 1. Electro-oculography eye-movement measurement.

Notes: Courtesy of Metro-Vision, Pérérenchies, France (<http://www.metrovision.fr>). Reproduced with permission.



Fig. 2. Tobii tracker 4c, an eye tracker based on pupil-corneal reflection vector method.

Notes: Courtesy of VA (<http://www.11d-tech.com>). Reproduced with permission.

CRediT authorship contribution statement

Qingya Lu: Writing – original draft. **Kunni Wei:** Writing – original draft. **Cong Yan:** Conceptualization, writing – review & editing, supervision.

Declaration of competing interest

The authors declare that there are no conflicts of interest.

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