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FUNDOSCOPY IN CATS

A practical guide and common findings

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Introduction

Fundoscopy is vital for diagnosing conditions such as retinal degeneration, hypertensive retinopathy and infectious diseases such as feline infectious peritonitis (FIP), while also enabling ongoing monitoring of disease progression and treatment response. With the advent of smartphone funduscopy, capturing and sharing high-quality fundic images has become more accessible, enabling general practitioners to consult with specialists and enhance diagnostic accuracy. Integrating routine funduscopy into clinical practice can lead to earlier diagnoses, better treatment outcomes and improved patient care.

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Tools and techniques for performing funduscopy

The two main techniques for examining the fundus are direct and indirect ophthalmoscopy. Each has its own advantages and disadvantages and they are complementary to each other. For example, if a lesion is identified with indirect ophthalmoscopy, direct ophthalmoscopy should be used to examine that lesion more closely. For information on the pros and cons of each technique, see Table 1 later.

Regardless of the technique used, it is important to follow a systematic approach when examining the fundus to avoid missing lesions. Key areas to assess are the optic disc (colour and size), the retinal vasculature (calibre, tortuosity and length), the tapetal fundus (reflectivity, pigment changes, haemorrhages, detachments) and non-tapetal fundus (pigment changes).

Direct ophthalmoscopy

The direct ophthalmoscope is readily available in all practices and provides an upright, magnified view of the fundus. To visualise the fundus, the lens dial should be set to zero. Clinicians who wear glasses should remove them and adjust the diopters according to their prescription using the lens dials. The light intensity should be kept low to avoid causing discomfort to the cat.

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Practical relevance: Comprehensive examination of the feline fundus should be in every clinician's arsenal. It is an integral part of both the physical and ophthalmic examination, especially in senior cats and in the presence of intraocular inflammation and visual impairment. Fundoscopy provides critical insight into a wide range of systemic diseases, often leading to quicker diagnoses and better treatment outcomes.

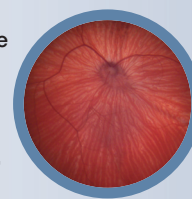
Clinical challenges: Practice is needed to become proficient and take high-quality photos of the retina. Distinguishing between normal variants and pathological findings can be challenging initially.

Evidence base: This review includes information from published references of common retinal pathologies in cats, as well as the authors' extensive experience on performing funduscopy.

Equipment: The essential tools for funduscopy include a direct and indirect ophthalmoscope, condensing lens and a focal light source. High-quality images of the fundus can be achieved with any smartphone.

Audience: This review is aimed at veterinary clinicians and outlines all the steps and equipment needed to confidently perform funduscopy. It also provides tips on how to capture photos of the fundus using a smartphone. Common findings are discussed in relation to different retinal pathologies.

Keywords: Retina; funduscopy; ophthalmoscopy; smartphone; hypertension; chorioretinitis; FIP



Preparing for a fundoscopic examination

- ✦ Collate the equipment needed (Figure 1):
 - Direct ophthalmoscope.
 - Condensing lens (eg, Volk, Volk Optical). The most widely used lenses are the 20D, 28D, Pan Retinal 2.2 and 30D. Among these lenses, the Pan Retinal 2.2 is regarded as the most versatile for the general practitioner, providing a good balance between magnification and field view.¹ See below for further information on condensing lenses.
 - Focal light source: Finoff transilluminator, pen torch, smartphone flashlight or strong otoscope light.



In order to perform fundoscopy, a practitioner needs a direct ophthalmoscope, a condensing lens and a focal light source.



Figure 1 Equipment needed for fundoscopy. From left to right: Finoff transilluminator, direct ophthalmoscope and condensing lens. A pen torch, smartphone flashlight or strong otoscope light can also be used as a light source

Condensing lenses

How do you use the lenses?

To use the lens, hold it between the thumb and index finger with the flatter side, marked by the silver rim (shown in Figure 2), facing the eye (alternatively think of the more convex, or 'fatter' side of the lens facing the examiner).

What is the difference between lenses?

The field of view in the image changes depending on the diopter strength (D) of the lens being used. Higher diopter lenses provide lower magnification and a larger field of view. For example, a 30D lens (Figure 3a) will provide a larger field of view compared with a 18D lens (Figure 3b) but the image will be less magnified.

Which is the best lens for the general practitioner?

The Pan-Retinal 2.2 is considered the most versatile lens as it combines the magnification of the 20D lens with the field of view of the 30D lens (Figure 4).

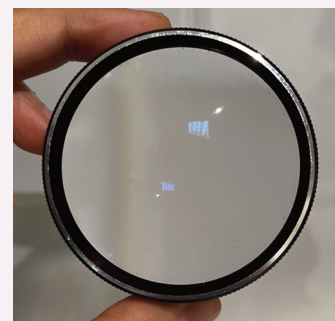


Figure 2 The silver side of a Volk condensing lens rim should be facing the eye

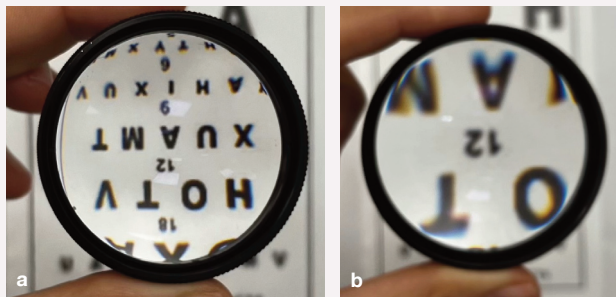


Figure 3 View with a (a) 30D lens compared with a (b) 18D lens



Figure 4 The Pan-Retinal 2.2 lens is considered the most versatile lens for the general practitioner

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To examine the fundus, the ophthalmoscope should be rested on the clinician's brow while visualising the tapetal reflex (otherwise known as the 'tapetal reflection'), beginning at arm's length. Once the tapetal reflex is visible, the clinician should gradually move closer until positioned 2–3 cm from the eye (Figure 5a). A systematic approach is recommended, starting with the optic disc and retinal vasculature, followed by the tapetal and non-tapetal fundus (see 'Normal cat fundus' box later).

Assessing the fundus in quadrants helps ensure no lesions are missed. If the view is lost, stepping back to locate the tapetal reflex before resuming the examination is advised.

Any lesions identified can be compared with the size of the optic disc. If a lesion is blurry at 0D but clear at positive diopters (eg, +2D), it means the lesion is elevated. Similarly, a lesion is depressed if it is in focus at negative diopters (eg, -2D).

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- ❖ Prepare the room:
 - The examination needs to be performed in a darkened room.
- ❖ Prepare the patient:
 - The cat needs to be held in a sternal position with the head stabilised by an assistant. Minimal handling

with gentle restraint is preferred.

- Dilatation of the pupil is necessary for a thorough fundoscopic examination. If the cat already has mydriatic pupils, there is no need for further dilation. See below for information on different mydriatics.

Mydriatics: what to use and when not to use

Tropicamide 0.5–1% is the preferred mydriatic for diagnostic purposes. It is a cholinergic antagonist that causes mydriasis through its parasympatholytic action on the pupillary sphincter. It has a rapid onset (15–20 mins) and short duration (maximal effect in 1–2 h and decline within 4 h),² which is why it is the mydriatic of choice for fundoscopy. It is available in preservative-free single dose containers (Minims, Bausch & Lomb) or a multi-use dropper bottle. The single dose containers are preferred to reduce cross-contamination between patients. Tropicamide can have a bitter taste so hypersalivation following administration is common.³ This usually lasts a few minutes. Other mydriatics, such as atropine and phenylephrine, are not recommended for diagnostic purposes. Atropine

has a long duration of action and it can persist for up to 60 h.³ Phenylephrine is ineffective as a sole mydriatic² in cats and can cause an increase in blood pressure with reflex bradycardia.⁴

The effect and the duration of the mydriasis can be influenced by ocular diseases such as uveitis, requiring multiple applications of the mydriatic to achieve sufficient results.

Pupil dilation is contraindicated in glaucoma, as it can cause a significant elevation in the intraocular pressure (IOP).⁵ Caution should also be applied in eyes with lens instability, as the lens may shift in the anterior chamber and cause secondary glaucoma. Therefore, it is essential to perform tonometry and check the lens position before proceeding with dilation.

Monocular indirect ophthalmoscopy

To obtain a clear view of the fundus, the light source should be positioned against the clinician's temple. The condensing lens should be held between the thumb and index finger, with the silver side facing the eye, and stabilised on the cat's head using one or two fingers. Once the tapetal reflex is visible, the lens should be positioned 2–4 cm from the eye (Figure 5b). If the image is lost due to head movement, removing the lens and repositioning is recommended.

Tips for indirect fundoscopy

- ❖ Rest the light on the clinician's temple and maintain good alignment between the light source, the lens and the pupil.
- ❖ Focus the condensed light beam through the pupil; the assistant can confirm this.
- ❖ If the image is not magnified and the fundus is not filling the entire lens, the lens should be moved towards the examiner.
- ❖ If the image is too magnified, the lens should be moved closer to the cat's eye.
- ❖ Only very small adjustments with the condensing lens are needed.



Figure 5 (a) Direct fundoscopy. After finding the tapetal reflex from a distance, the clinician is moving closer to the eye to get to a position 2–3 cm away. (b) Indirect fundoscopy. The light source is held close to the clinician's temple to achieve good alignment between the light, lens and pupil

This technique provides an inverted and reversed view of the fundus. Maintaining lens stability while adjusting position allows for a comprehensive examination of the entire fundus. More tips on indirect fundoscopy can be found in the box above.

The PanOptic ophthalmoscope is another tool for monocular indirect ophthalmoscopy, providing a real image with magnification that falls between direct and indirect ophthalmoscopy.

Table 1 compares direct and indirect ophthalmoscopy.

Table 1 Pros and cons of direct vs indirect fundoscopy	
Direct	Indirect
Readily available	Requires condensing lens
Upright magnified view of the fundus – easier to navigate around the fundus	Inverted and backwards view of the fundus – requires practice to navigate around the fundus
Small field of view makes surveying the whole fundus more challenging	Large field of view makes surveying the whole fundus easier
Challenging to use when the ocular media is not clear (eg, cataracts)	Can achieve a better view though opacities at the ocular media
Need to get very close to the cat, which may not be tolerated	Can keep a greater distance from the cat, which may be better tolerated

Smartphone fundus photography: a practical, cost-effective tool for every clinician

Fundus photography is a powerful clinical tool for disease monitoring but also seeking specialist advice. While specialised fundic cameras can produce high-quality photos of the fundus, they are expensive. Smartphone fundoscopy offers a simple and cost-effective alternative.

This technique follows the same principles as indirect fundoscopy but uses the smartphone camera as an indirect ophthalmoscope.

The phone's flash acts as the light source and the camera display screen replaces the examiner's eye.

As with traditional fundoscopy, pupil dilation is necessary and the examination should be conducted in a darkened room to minimise glare from the environment. An assistant is again needed to restrain the cat and hold the eyelids open.

Capturing video and saving the best screenshots is preferred over taking still photos, as it can be challenging to capture a well-focused image due to the cat's eye and head movements.

Performing smartphone fundus photography

Equipment

- ❖ Smartphone
- ❖ Condensing lens
- ❖ Phone's native camera app and micropore tape or a camera app that allows the flash intensity to be adjusted and the flash to be used as a torch while filming

Any smartphone is suitable for fundic photography. Ideally, the camera lens should be close to the flash. For smartphones with multiple lenses, the lens closest to the edge of the phone should be selected, which can typically be done through the camera app.

Steps

- ❖ The lens closest to the phone's flash should be selected in the camera settings. The correct lens can be identified by occluding each lens with a finger while switching between options.
- ❖ Switch to video mode and turn on the flash continuously.
- ❖ Reduce the flash intensity either by applying layers of semi-transparent tape (eg, micropore tape) to the flash or by using a camera app. The number of tape layers will depend on the tape's thickness and the reflectivity of the fundus; more reflective lesions may require additional layers (Figure 6).
- ❖ The phone should be held 18–20 cm from the cat's eye (this distance may vary based on the phone's minimum focal distance).
- ❖ Zoom in by x 2 to x 2.3.
- ❖ The camera should be pointed at the cat's eye, ensuring the tapetal reflex is centred on the screen before recording.
- ❖ The lens is stabilised on the cat's head and positioned 2–4 cm from the eye, following the technique used in indirect fundoscopy.
- ❖ Slight adjustments to the camera or lens position may be necessary to obtain a complete view of the fundus.
- ❖ Once the optimal position is achieved, the imaginary axis



Figure 6 Six layers of micropore tape were applied to reduce the intensity of the flash of this phone

Prolonged exposure to light should be avoided as it can cause photoreceptor damage and can be uncomfortable for the cat. An exposure time of less than 1 min is recommended, though this may vary depending on the power of the smartphone flashlight.

- ❖ between the camera, lens and pupil should be maintained.
- ❖ To capture the entire fundus, the lens–phone axis should be kept steady while adjusting position, similar to the technique used in indirect fundoscopy.
- ❖ The best screenshots from the video can then be saved.

An example of a video captured when using this technique can be seen in Video 1 in the supplementary material. Table 2 outlines common issues and troubleshooting.

Table 2 Common issues and troubleshooting for smartphone fundus photography

Issue	Solution
Finding the appropriate distance between the phone and the lens	Practice is essential. While there are attachments that hold the lens at a fixed distance, they can be expensive and are not necessary
Not getting a consistent image of the fundus	The lens and camera should be moved as a single unit. Imagine there is a line connecting the phone and the lens
Overexposed image	The flash's intensity should be reduced through an app or by applying more micropore tape on the flash
Glare artefacts on the lens	The room must be completely dark or the flash intensity should be reduced. If the artefact persists, the lens can be slightly tilted to change the position of the glare – see images below



Fundic findings

Congenital abnormalities

Congenital abnormalities are rarely reported in cats and they are usually associated with eyelid agenesis. Fundoscopic signs include coloboma of the optic nerve, retina and choroid.⁶ Retinal dysplasia in the form of hyporeflective retinal folds may also be present.

Retinal dysplasia

Inherited eye disorders are relatively rare in cats. Retinal dysplasia has been described in certain breeds such as the Somali,⁷ Persian,⁷ and Norwegian Forest Cat.⁸ A link to intrauterine or early neonatal viral infection with feline leukaemia virus (FeLV) has also been documented.⁹

The hallmark of retinal dysplasia is the presence of retinal folds or rosettes, resulting from abnormal retinal development. These appear as hyporeflective linear or oval lesions at the tapetal fundus (Figure 9).

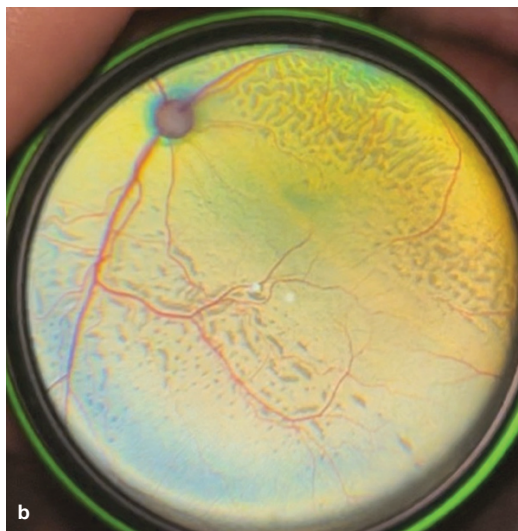
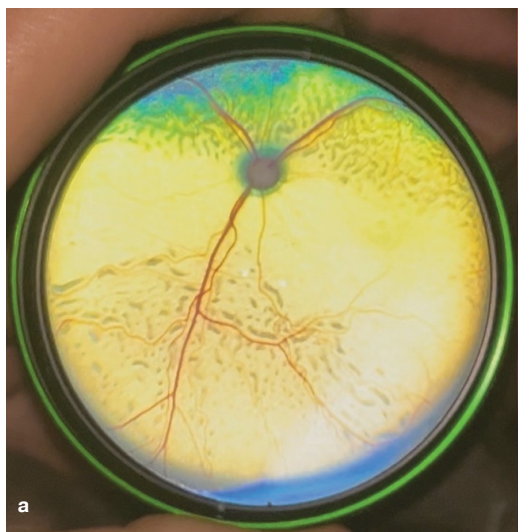


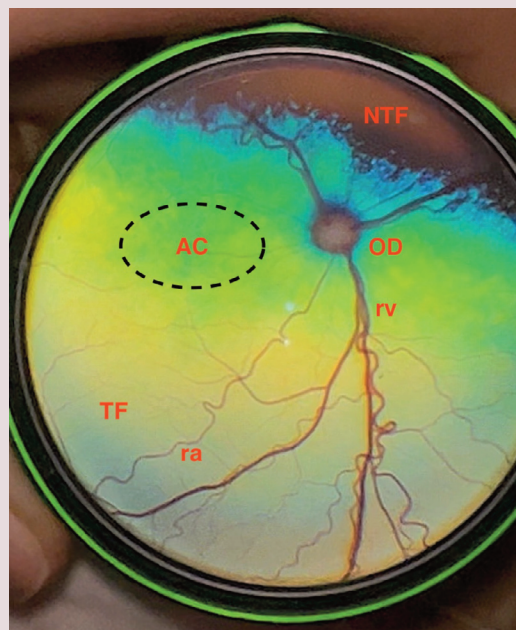
Figure 9 (a,b) Presence of retinal folds in a cat suspected to have retinal dysplasia

Normal cat fundus

The feline fundus is divided into the optic disc, retinal venules and arterioles, and tapetal and non-tapetal fundus (Figure 7).

- ❖ **Optic disc** Cats have a small, circular optic disc, typically located in the tapetal fundus. Normal variations include pigment around the disc or a zone of tapetal hyper-reflectivity, known as the conus.
- ❖ **Retinal vasculature** Three pairs of cilioretinal arterioles and venules, along with smaller arterioles, emerge from the periphery of the optic nerve head. The retinal venules are larger and darker in colour compared with the arterioles, which are lighter and can be more tortuous.
- ❖ **Tapetal and non-tapetal fundus** The non-tapetal fundus appears as a dark brown area located in the ventral fundus, whereas the tapetal fundus is the reflective, yellow-green triangular area located at the dorsal fundus. An important area of the tapetal fundus is the area centralis, located 3 mm dorsolateral to the optic disc, which has the highest cone density in cats (area outlined by a dashed line in Figure 7).¹⁰

Figure 7 Normal cat fundus photographed with a smartphone. AC = area centralis; NTF = non-tapetal fundus; OD = optic disc; ra = retinal arterioles; rv = retinal venules; TF = tapetal fundus



Subalbinotic fundus

A common normal variation that may be mistaken for pathology is the subalbinotic fundus.

This occurs in colour-dilute cats with blue eyes, where there is a partial or complete absence of the tapetum and melanin in the retinal pigmented epithelium (RPE). As a result, the underlying choroidal vessels are exposed, giving the fundus a red appearance (Figure 8).

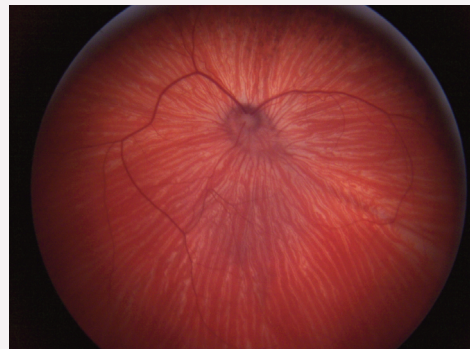


Figure 8 Subalbinotic fundus in a colour-dilute cat. The red appearance of the fundus is due to the exposure of the underlying choroidal vessels. Courtesy of David Kayes

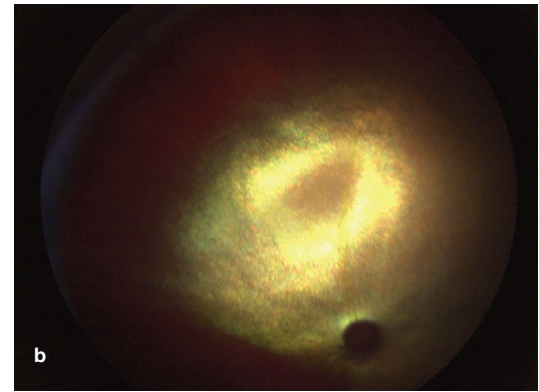
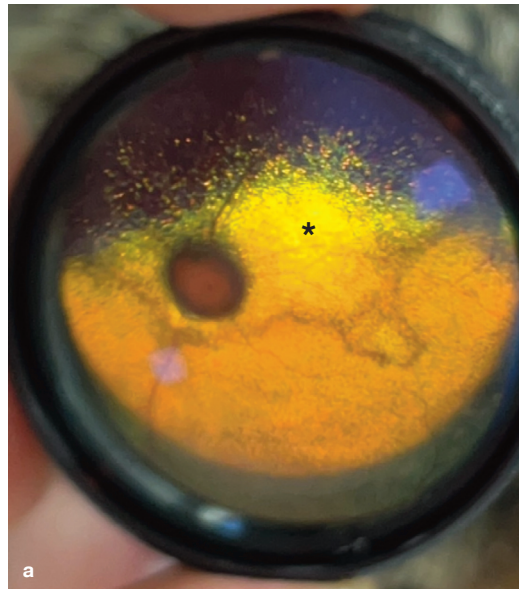


Figure 10 (a) Early stage of retinal degeneration with focal tapetal hyper-reflectivity (asterisk) and retinal blood vessel attenuation. (b) Advanced retinal degeneration with absence of retinal vasculature, diffusely hyper-reflective tapetal fundus and a small dark optic disc. Note the red appearance of the non-tapetal fundus (subalbinotic variation). Images courtesy of David Kayes

Retinal degeneration

Progressive retinal atrophy and inherited retinal diseases, such as rod–cone dysplasia and rod–cone dystrophy, are infrequently reported in purebred breeds such as the Bengal, Abyssinian and Somali.^{11,12} Other causes of retinal degeneration include taurine deficiency and enrofloxacin toxicity.

On fundoscopy, there are various degrees of tapetal hyper-reflectivity due to retinal thinning, in addition to retinal vascular attenuation (Figure 10a). In advanced cases, the retinal vasculature is entirely absent and the optic disc appears small and dark, indicating atrophy (Figure 10b).

Feline central retinal degeneration (FCRD)

FCRD is caused by a deficiency of taurine, which is an essential amino acid for retinal and cardiac function.¹³ Cats have a limited ability to synthesise taurine and require dietary supplementation. While deficiency has become less common due to commercial cat foods enriched with taurine, it can still occur in cats fed non-commercial diets¹⁴ or those with impaired taurine absorption.

The lesions on fundoscopy are bilaterally symmetrical and initially affect the area centralis. Early clinical signs include granularity of the tapetum at the area centralis, followed by the appearance of an ellipsoid hyper-reflective lesion lateral to the optic disc (Figure 11). As the deficiency progresses, a second similar lesion appears medial to the optic disc and the two lesions eventually coalesce. Generalised retinal degeneration with diffuse tapetal hyper-reflectivity and attenuation of the retinal blood vessels follows.¹⁵

Feline central retinal degeneration can occur in cats fed non-commercial diets or cats with impaired taurine absorption.



Tapetal changes typically develop within 3 to 7 months, with complete retinal degeneration occurring by 9 months of deficiency.¹⁶ Although vision and retinal function may improve after taurine supplementation, the fundic lesions are permanent.¹⁷ Detection of these lesions should prompt measurement of taurine plasma levels and also cardiac evaluation as FCRD can be linked with dilated cardiomyopathy.¹⁸

FCRD is usually an incidental finding, unless the disease is advanced. In such cases, dietary history should be reviewed, and taurine plasma levels should be assessed.

Enrofloxacin-related retinal toxicity

Enrofloxacin has been historically associated with acute and severe retinal degeneration in cats due to a defect in a transport protein in the blood–retinal barrier, which allows accumulation of photoreactive fluoroquinolones and causes retinal damage.¹⁹

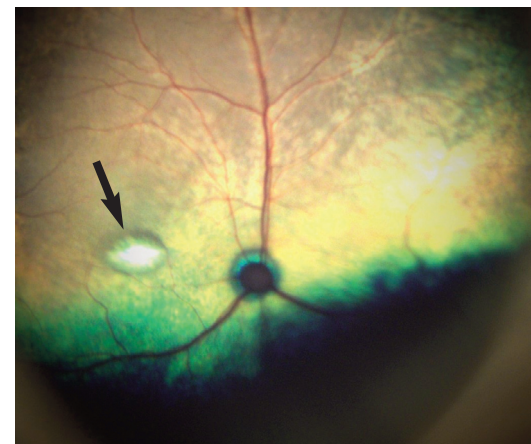


Figure 11 Characteristic oval-shaped hyper-reflective lesion (arrow) in the area centralis secondary to taurine deficiency

Risk factors include older cats with compromised renal/hepatic function, high doses (over 2.5 mg/kg q12h) and intravenous administration.²⁰ The onset of the toxicity is rapid, with retinal degeneration evident within days after administration and even after a single dose.

On fundoscopy, there is severe and diffuse tapetal hyper-reflectivity, in addition to marked retinal blood vessel attenuation. The retinal changes and blindness are permanent, even after discontinuing the drug.

To prevent such outcomes, fluoroquinolone use in cats should be avoided whenever possible, opting for safer alternatives. If the use of a fluoroquinolone is deemed necessary, the lowest effective dose should be used for the shortest possible duration. While pradofloxacin has shown no retinal toxicity in young, healthy cats,²⁰ all fluoroquinolones should be regarded as potentially retinotoxic.²¹

Changes due to systemic hypertension (SHP)

SHP in cats is defined as a persistent systolic blood pressure above 160 mmHg on repeated measurements taken on more than two occasions.²² It is most commonly associated with chronic kidney disease and hyperthyroidism. A systolic blood pressure above 180 mmHg is linked to target organ damage²³ and the eye is susceptible to damage from SHP due to its small-calibre blood vessels. SHP is frequently seen in cats over 10 years of age, with acute-onset blindness being the most common clinical presentation (Figure 12),²⁴ which then prompts blood pressure measurement.

SHP affects the retina through three mechanisms:^{23,25}

- ❖ Retinal arteriole constriction due to autoregulatory responses leads to ischemic necrosis, vessel wall rupture and increased permeability, causing leakage of blood. On fundoscopy, this manifests as retinal arteriole narrowing (beading), increased tortuosity, retinal oedema, haemorrhages and macro-

All fluoro-quinolones should be considered potentially retinotoxic in cats.

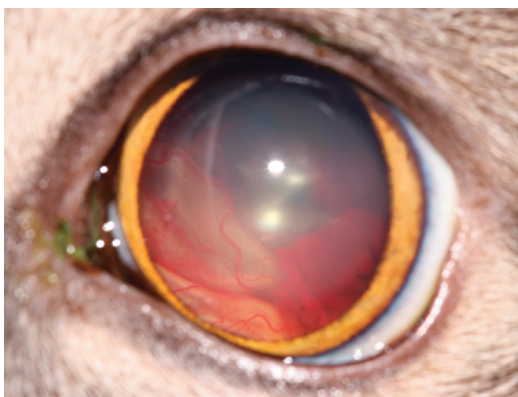


Figure 12 Photo of a cat that presented with acute-onset blindness. Retinal detachment and vitreal haemorrhage are visible

For a detailed guide on fundic lesions associated with hypertension in cats, readers are referred to the 2019 Clinical Review 'Hypertensive ocular disease in cats: a guide to fundic lesions to facilitate early diagnosis' by Jenny Carter, DOI: 10.1177/1098612X18818668

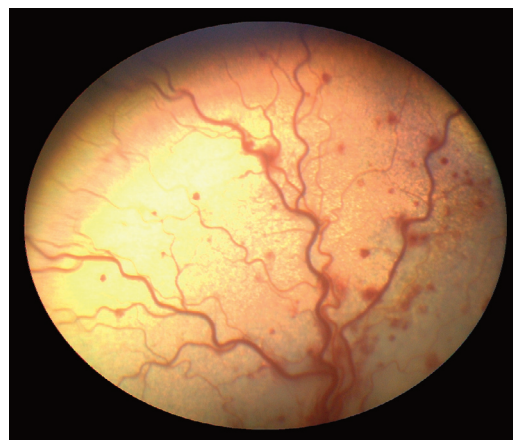


Figure 13 Retinal blood vessel tortuosity and retinal haemorrhages in the tapetal fundus of a cat with hypertensive retinopathy

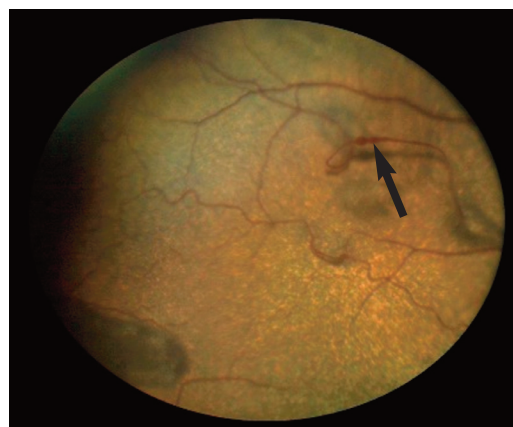


Figure 14 A macroaneurysm (arrow) is visible on a retinal arteriole in the fundus of a cat with hypertensive retinopathy



Figure 15 Multiple bullous retinal detachments in a cat with hypertensive choroidopathy

aneurysms (Figures 13 and 14). This condition is termed hypertensive retinopathy.

- ❖ Choroidal vascular changes lead to accumulation of subretinal fluid and partial or complete retinal detachment. This appears as single or multiple bullous retinal detachments, sometimes involving the entire retina, along with degenerative lesions in the RPE. This is termed hypertensive choroidopathy (Figure 15).

- ❖ Ischaemia of the optic nerve leads to papilloedema and ultimately to optic atrophy.

This is termed hypertensive optic neuropathy and it is a less common fundic manifestation of SHP.

Early detection of fundic lesions associated with SHP is crucial to prevent blindness, as cats with milder fundic abnormalities at diagnosis have a better long-term prognosis for vision. Fundoscopy should therefore be part of the routine health screening of older cats.

Cats with severe fundic abnormalities may show initial improvement with retinal reattachment and absorption of haemorrhages; however, long-term prognosis for vision is poor due to secondary retinal degeneration (Figure 16). Fundoscopy should be performed alongside blood pressure measurement at rechecks, after initiation of antihypertensive therapy.

Chorioretinitis

Systemic diseases often manifest in the feline fundus in the form of chorioretinitis, which results from inflammation in the choriocapillaris and disruption of the blood-retinal barrier.

Understanding the distinction between active and inactive chorioretinitis lesions is crucial in diagnosis and disease progression assessment. The key differences between

The eye is susceptible to damage from systemic hypertension due to its small-calibre blood vessels. A systolic blood pressure above 180 mmHg is linked to target organ damage.

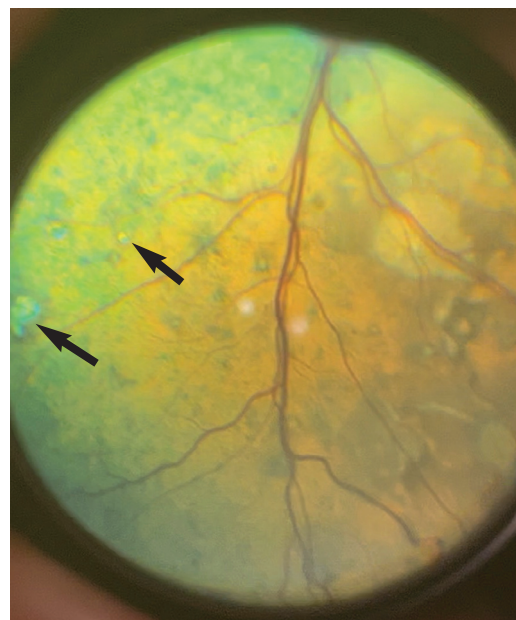


Figure 16 Multifocal retinal degeneration with areas of tapetal hyper-reflectivity (arrows) at the sites of previous bullous detachments

active and inactive chorioretinitis lesions are outlined in the box.

Common systemic diseases with fundic manifestations include viral, fungal, protozoal and bacterial diseases.

Key differences between active vs inactive chorioretinitis

Active chorioretinitis (Figure 17)

- ❖ Hyporeflective areas at the tapetal fundus due to retinal oedema
- ❖ Haemorrhages
- ❖ Retinal detachment
- ❖ Inflammatory or neoplastic cell infiltration
- ❖ Granulomas (mycotic or parasitic)
- ❖ Exudates

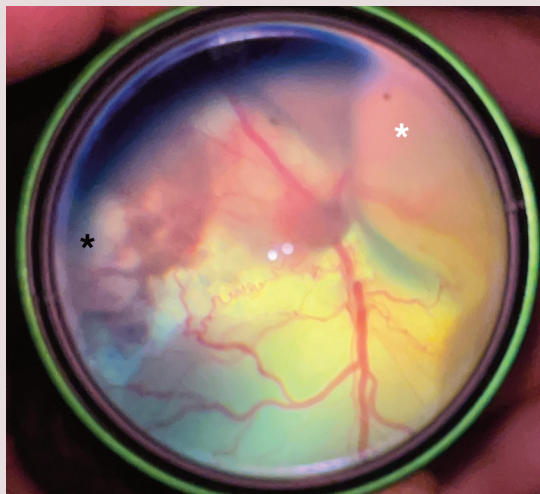


Figure 17 Active chorioretinitis with retinal haemorrhages, inflammatory infiltrates (black asterisk) and retinal detachment (white asterisk). Courtesy of David Kayes

Inactive chorioretinitis (Figure 18)

- ❖ Chorioretinal scars (hyper-reflective areas at the tapetal fundus due to retinal thinning with pigment deposition at their centre)
- ❖ Pigment disturbances at the tapetal fundus
- ❖ Depigmentation of the tapetal fundus

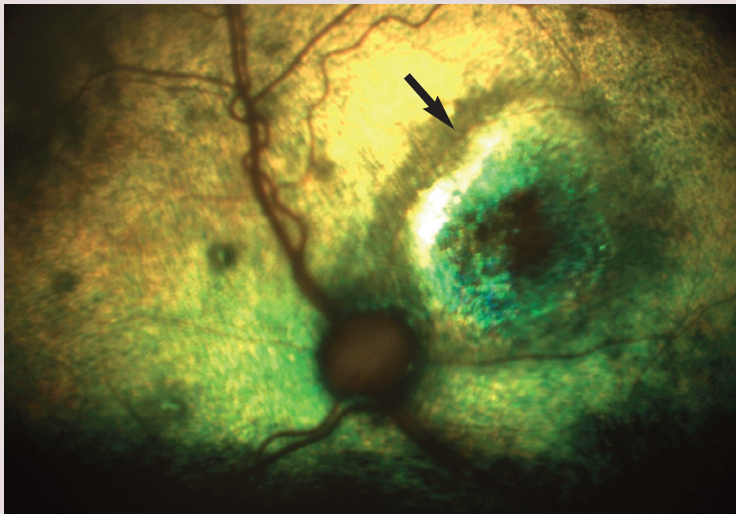


Figure 18 Inactive chorioretinitis with focal areas of tapetal hyper-reflectivity and pigment disturbances (arrow)

Viral chorioretinitis

Feline infectious peritonitis

FIP is the most common cause of viral chorioretinitis in cats, and ocular signs are sometimes the first clinical indication of the disease.²⁶ Ocular lesions are more frequently observed with the non-effusive (dry) form of FIP.²⁷

Bilateral chorioretinitis with perivascular cuffing is the most common finding on fundoscopy. Perivascular cuffing appears as pyogranulomatous exudates surrounding the retinal blood vessels.²⁸ It is caused by the deposition of macrophages containing the FIP virus in the endothelium of small blood vessels, leading to inflammation and damage to vascular structures. The resulting vasculitis leads to bullous partial retinal detachments. Optic neuritis has also been reported in cases where the central nervous system (CNS) is affected, seen as a swollen, hyperaemic optic disc with blurred margins.²⁹

Early identification of fundic abnormalities can help lead to a timely diagnosis and management of FIP.

Feline leukaemia virus and feline immunodeficiency virus (FIV)

Retinal abnormalities are uncommon in cats with FeLV and FIV. FeLV has been reported to cause retinal haemorrhages secondarily to severe anaemia in both the tapetal and non-tapetal fundus.³⁰ FIV has been associated with chorioretinitis lesions due to coinfections with other pathogens such as *Toxoplasma gondii*.

Protozoal chorioretinitis

Toxoplasmosis

T gondii is one of the most commonly implicated pathogens in feline chorioretinitis. Inflammation and tissue damage are caused by both the protozoa and the host inflammatory response.

Granulomatous chorioretinitis and optic neuritis are the most common fundic lesions. Active lesions often appear as multifocal hyporeflective lesions in the tapetal fundus with white fluffy infiltrates in the non-tapetal fundus.³¹

Since *T gondii* is suspected in most cases of feline chorioretinitis, *T gondii*-specific IgM and IgG titres are routinely performed to confirm diagnosis in the presence of chorioretinitis lesions.

Mycobacterial chorioretinitis

Mycobacterial infections in cats are increasingly recognised, particularly those caused by *Mycobacterium bovis* and *Mycobacterium microti*.³² A notable recent outbreak was linked to contaminated commercial raw diets.³³

Ocular manifestations of systemic mycobacterial disease are seen in 6% of affected cats.³² Ocular clinical signs are typically unilateral but can also be bilateral.

Fundic abnormalities may be the first clues of underlying systemic disease and identifying these lesions can mean the difference between sight-saving treatment and irreversible blindness.



Fundoscopy findings include granulomatous to pyogranulomatous chorioretinitis, with or without retinal detachment and optic neuritis.³⁴

Ocular mycobacteriosis can occur without systemic signs, making fundoscopic examination critical in suspect cases.

Mycotic chorioretinitis

Cryptococcosis is the most common systemic mycosis in cats,³⁵ but other systemic mycoses like blastomycosis, histoplasmosis and coccidioidomycosis may also be encountered, depending on the geographical location.

Fundoscopy findings include granuloma formation in the tapetal or non-tapetal fundus, retinal detachments and optic neuritis if the central nervous system is involved.³⁵

All cats exhibiting signs suspicious of fungal disease, such as nasal and facial swelling, deep non-healing nasal wounds or nasal polyps should undergo fundoscopic examination to check for retinal lesions.

Neoplastic disease

Primary retinal neoplasia in cats is rare, while secondary neoplasia is more common. One of the most characteristic metastatic retinal lesions in the feline retina are due to carcinomas of the lung and mammary tissue.^{36,37}

The fundic lesions appear as wedge-shaped, tan-to-grey areas radiating from the optic disc in the tapetal fundus. The underlying pathogenesis is thought to involve neoplastic embolisation of the short posterior ciliary arteries, leading to necrosis of the retina and choroid. Intraretinal haemorrhages may also be present.

Optic nerve head lesions

Optic neuritis

Optic neuritis appears to be uncommon in the cat. Inflammation of the optic nerve can be caused by a variety of systemic diseases previously discussed, such as FIP, toxoplasmosis and cryptococcosis. On fundoscopy, the optic disc appears swollen and hyperaemic with blurred margins.

Optic atrophy

Optic atrophy is a common sequela of retinal degeneration but also glaucoma, chronic optic neuritis or trauma (stretching due to proptosis or enucleation of the contralateral globe). The optic disc appears small and dark.

Since *Toxoplasma gondii* is suspected in most cases of feline chorioretinitis, *T gondii*-specific IgM and IgG titres are routinely performed to confirm diagnosis in the presence of chorioretinitis lesions.



Case notes

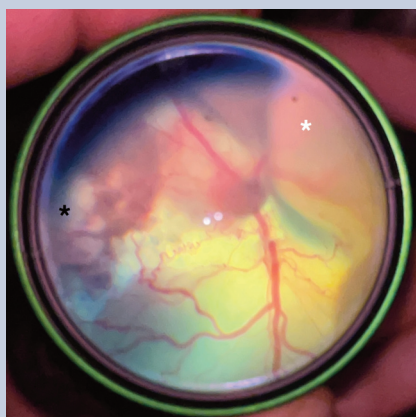
An 8-month-old domestic shorthair cat presented with acute-onset blindness.

Signalment The cat had a 1-month history of cloudy eyes and the owner reported that in the 2 weeks prior to presentation, both pupils were mydriatic. The cat also had a history of pyrexia, lethargy, inappetence and sneezing.

Clinical examination Upon presentation, the cat was underweight with a body condition score of 4/9. Abdominal palpation revealed thickened intestines. A rectal temperature of 39.7°C was also noted.

Ophthalmic examination Both eyes were blind, with an intact but slow pupillary light and dazzle reflex. Signs of anterior uveitis were present, with keratic precipitates and significant aqueous flare.

Fundoscopy revealed bilateral bullous retinal detachments



(a) Bullous retinal detachment (white asterisk), with retinal haemorrhages and inflammatory infiltrates (black asterisk) were found on fundoscopy. Courtesy of David Kayes

with perivascular cuffing, peripapillary retinal haemorrhage and multifocal cream-colour foci, suspected to be inflammatory infiltrates (image a).

Given the signalment (young, systemically unwell cat) and the characteristic fundoscopic lesions, FIP was strongly suspected.

Further investigations

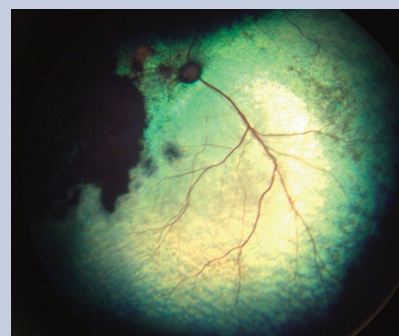
- ❖ Haematology: largely unremarkable
- ❖ Biochemistry: elevated total protein with low albumin and elevated globulins, a common finding with FIP cases.
- ❖ Elevated alpha-1-acid glycoprotein (AGP): >2000 µg/ml (normal reference interval <500 µg/ml), strongly indicative of FIP.

Diagnosis Based on the signalment, clinical presentation, fundoscopic findings and elevated AGP levels, a presumptive diagnosis of FIP was made.

Treatment The cat was treated with GS-441524 antiviral tablets to address the systemic viral infection and bromfenac eye drops to control the uveitis and prevent further ocular damage. Topical steroid eye drops were avoided, as due to the history of sneezing, there were concerns over feline herpesvirus recrudescence.

Outcome Six weeks after starting treatment, the cat showed significant improvement:

- ❖ The cat had regained vision and returned to normal activity levels.
- ❖ Repeat fundoscopy revealed that the retinal detachments and haemorrhages had resolved. Multiple areas of tapetal hyper-reflectivity and pigment deposition were present (image b).



(b) Six weeks after treatment, the retinal detachments and haemorrhages had resolved and signs of retinal degeneration were present with tapetal hyper-reflectivity and pigment disturbances

❖ **What this case demonstrates:** This case highlights the importance of fundic examinations in systemically unwell cats. Early diagnosis and treatment of FIP not only preserved the cat's vision, but also effectively managed the systemic viral infection. Fundoscopy played a crucial role in identifying characteristic lesions and guiding the diagnosis and treatment plan.

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Supplementary material

The following file is available as supplementary material:

Video 1: Example of a video captured when performing smartphone fundus photography.

Conflict of interest

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KEY POINTS

- ❖ The two key methods for examining the fundus are direct and indirect ophthalmoscopy, which are complementary. Indirect ophthalmoscopy is ideal for obtaining a general overview of the fundus, while direct ophthalmoscopy allows for a more detailed inspection of specific lesions.
- ❖ A thorough, systematic approach is essential to avoid missing lesions. The examination should include assessment of the optic disc, retinal vasculature, tapetal fundus and non-tapetal fundus.
- ❖ Smartphone fundoscopy is a cost-effective alternative to specialised fundic cameras and it uses video recording to capture clear images. Proper alignment between the camera, condensing lens and pupil is necessary to obtain good images of the fundus.
- ❖ Systemic diseases such as systemic hypertension and FIP have characteristic fundoscopic lesions. Prompt intervention in such cases can lead to favourable outcomes, both visually and systemically.



Ethical approval

This work did not involve the use of animals and therefore ethical approval was not specifically required for publication in *JFMS*.

Informed consent

This work did not involve the use of animals (including cadavers) and therefore informed consent was not required. For any animals or people individually identifiable within this publication, informed consent (verbal or written) for their use in the publication was obtained from the people involved.

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