Examination of the eye

Overview

Many doctors feel that their skills in assessing eye conditions are limited, or even not adequate. Others may feel that the absence of a slit lamp in most primary care surgeries means that conditions beyond the conjunctiva can hardly assessed at all. This is simply not true.

Whilst many eye conditions do require dilation (not always convenient in a short primary care appointment) and/or slit-lamp examination, history taking in ocular complaints is very similar to that taken with other problems and examination can be straightforward if you always keep in mind what you are looking for. The basic function of the eye can be assessed using simple desktop tools. As with any physical examination, you need not carry out every test - functional ones should be directed by history and anatomical examination - but practice will increase confidence.

History[1]

The structure of ophthalmological history taking is no different than for other systems; however, it is important to take particular note of the following:

- **History of presenting complaint** - the time and speed of onset, ocular associations (eg, red eye, pain, photophobia, blurry vision, etc), systemic associations (eg, headaches, nausea, rash on the forehead) and what the fellow eye is up to - a surprising number of patients fail to tell you about symptoms in there.
- **Past ocular history** - similar episodes, other episodes, surgery, 'lazy eye' (amblyopia).

- **Social history** - work (eg, the nursery nurse susceptible to conjunctivitis), home help/carers (eg, whether they will be able to open a drop dispenser or self-administer drops), independence (eg, this may tip the balance one way or another when deciding on whether to operate on a borderline cataract).

Selecting the appropriate examination

Not all examinations need be carried out on every patient: examination should be based on the history, the possible diagnoses and, therefore, the signs you are looking for.

Eye examination involves both anatomical examination and functional evaluation. Both are possible in primary care, although some conditions cannot be excluded without recourse to secondary care equipment such as slit lamps and tonometers.

Visual acuity testing should be carried out in all eye assessments, since even if no alteration is reported by the patient, it may be there. Suggestions for minimum necessary examination in other complaints include:

- **Red or painful eye**: the lids (possibly everted), lacrimal system, conjunctiva, cornea, pupils and anterior chamber should be examined and (depending on clinical suspicions) the patient may need slit-lamp examination and/or intraocular pressure measurement.
- **Foreign body (FB)**: the everted lids, conjunctiva and cornea need close examination, with particular attention to the edge of the iris where small specks can be difficult to spot. If the mechanism of injury suggests high-velocity FB, full anatomical examination of the eye is mandatory. This will usually mean review in secondary care where slit lamp and X-ray are available.
- **Reduced vision**: examination should cover the whole visual/refractory axis - from cornea to fundus, with functional testing of pupils, optic nerve and macula. If visual loss is stated or detected or there are neurological symptoms, visual fields should always be checked.
- **Double vision/orbital problems**: examine the fundus and optic nerve function in addition to extraocular muscle function.

- **Headache/problems suggesting neurological cause in absence of red eye**: examine the fundus; examine and test the optic nerve, pupillary functions and blood pressure; perform appropriate neurological examination.

Anatomical examination[2]

Work systematically from front to back. See also the separate Conditions Affecting the External Eye article.

Lids

Basic examination

Note position with regard to the fellow eye (ptosis), redness ± swelling (orbital cellulitis), lacerations (full thickness vs partial thickness, involvement of the puncta) and lumps/bumps (chalazion, sebaceous cysts). Note any skin abnormality - rashes (varicella zoster), ulcerations (basal cell carcinoma), ill-defined thickening (squamous cell carcinoma). Check eyelashes - if you have access to a slit lamp, look at them under magnification (blepharitis, ectropion, entropion).

Lid eversion

- **Indication**: suspicion of FB, examination of papillae/follicles.
- **Requirements**: topical local anaesthetic (LA), two clean cotton buds.
- **Procedure**: explain to the patient what you are going to do:
    - Place an anaesthetic drop in the lower fornix.
    - Ask them to look down, firmly hold eyelashes with index/thumb of one hand and place a cotton bud at the base of the lid with the other hand.
    - Gently pull the lid down and towards you whilst keeping the cotton bud firmly in place, before lifting the lid directly up (and maintaining pressure on the cotton bud) whilst reminding the patient to keep looking down.
    - Hold the lid in place with the 'eyelash hand' and examine the tarsus and fornix.
    - Use the clean cotton bud to 'dust' off any foreign material (it is typically quite firmly embedded).

Lacrimal system

Examine the lids, as above, and look at the puncta (the openings to the canaliculi - tear drainage channels): are they sitting against the globe, turned in (entropion) or drooping out (ectropion)? Look for swellings medial to the canthus - where the lids meet (blocked tear ducts) and any evidence of redness, pain or discharge (dacryocystitis).

Assessing for dry eye

- **Requirements**: fluorescein stain (dilute drops), cobalt blue light.
- **Procedure**: explain the dry eye assessment 'procedure' to the patient:
    - Instil a drop of fluorescein and look at the cornea, using cobalt blue light.
    - Ask the patient to close their eyes, then open them. For each eye, count the number of seconds it takes for the tear film (visualised as a hazy diffuse spread of fluorescein over the cornea) to break up. It should take at least 10 seconds.
    - Schirmer's test involves strips of filter paper and waiting for several minutes for tear absorption; however, this takes longer and is not always reliable.

Conjunctiva

- Observe for colour - injection (conjunctivitis), pallor (anaemia), cysts (clear blebs), concretions (yellow deposits), ulcerations.
- Look for FBs embedded in the fornices or hidden in folds (ask the patient to look far left, then right).
- Note any discharge.
- Look for presence of follicles or papillae (seen as little bumps in the conjunctival surface).
- Lid eversion (as above) may be necessary to assess the presence of follicles (raised, gelatinous pale bumps) or papillae (vascular bulges) and to rule out conjunctival FBs.
- Fluorescein staining of the conjunctiva will highlight small lacerations.

Cornea

- Is the patient wearing their contact lens? If you suspect a bacterial keratitis, the lens needs to be sent to the microbiology laboratories (check with your laboratory with regard to local policy about how to store the lens).
- Is the cornea hazy (all over - eg, acute angle-closure glaucoma - vs localised - eg, band keratopathy) or clear?
- Are there any white dots visible before fluorescein staining (infiltrates suggestive of infective keratitis).
- Check sensation (neuropathic keratopathy): twist a clean cotton bud/tissue to a tip and lightly touch the cornea - brisk reaction should immediately follow.
- Fluorescein staining: a single drop is sufficient. If using the strip, apply it once on the sclera or in the fornix, not on the highly sensitive cornea; then ask the patient to blink a few times. Look for diffuse tiny spots (punctate epithelial erosion from dry eye) or presence of ulcers (eg, herpes simplex keratitis). If your suspicions are strong but you cannot see anything, refer, as these lesions can be tiny but require treatment.
- If you suspect a penetrating injury, Seidel's test may detect leakage of aqueous through the vivid change in colour of fluorescein on dilution when viewed in blue light. The test is normally performed with a slit lamp:
    - **Requirements**: fluorescein, cobalt blue light source (on some ophthalmoscopes and pen torches). One paper recommended 10% fluorescein for this test, since it is more concentrated; however, this is not usually available in primary care as its primary use is in fluorescein angiography [3] .
    - **Procedure**: apply the fluorescein, using a strip to the suspicious area, asking the patient not to blink. View under the cobalt blue light. If it turns from dark non-fluorescent orange to a swirly bright fluorescent yellow/green, aqueous is leaking out (diluting it). The patient should be made nil by mouth, a hard eye shield should be applied and an urgent referral made.
    - Do NOT apply pressure to the globe when performing this test.

Anterior chamber

- Assessment is limited without a slit lamp but observe for hypopyon - a collection of pus sitting inferiorly (eg, endophthalmitis) or hyphaema - blood in the anterior chamber (eye trauma).
- If you have a slit lamp, further assess by narrowing the beam to 1 mm and putting it on its brightest light setting. Angle it at 30-45° to the cornea and focus in, past the cornea into the anterior chamber. If the iris comes into focus, you have focused too far. Look for cells (like particles of dust passing through the shaft of light) and for flare (slight cloudiness), suggestive of anterior uveitis.

Pupils[4]

- Look at their relative size - if you suspect anisocoria (different-sized pupils), stand back from the patient, darken the room and look through the ophthalmoscope. You can elicit the red reflex in both eyes and compare the size of these directly rather than shifting from one to the other close up.
- Look for change in shape (typically oval in acute angle-closure glaucoma, asymmetry in a penetrating injury) and any abnormal oscillations (Adie's tonic pupil syndrome, or Holmes-Adie pupil, an autonomic condition featuring mydriasis with poor or sluggish pupillary constriction in bright light, with slow re-dilation).

Lens and the red reflex[5]

- A cataract is not always easy to spot without a slit lamp unless it is very mature. However, you may notice an opacity by examining the red reflex: this is best seen with a dilated pupil when the patient is looking at the light of the ophthalmoscope which is held about an arm's length away from the patient. Look through the ophthalmoscope and turn the dial until you see the red reflex. This can be attenuated by any opacity between the cornea and the fundus: a corneal opacity is visible externally and a vitreous opacity may be mobile.

- The red reflex is part of the routine neonatal check. Use a direct ophthalmoscope in a dimly lit room and hold your ophthalmoscope about 2/3 of an arm's length away from the baby. If the baby is screwing their eyes shut, ask the mother to feed them and check it during the feed. Very occasionally, a neonate may need dilating to check the red reflex. If this is the case, it is best to refer to an ophthalmologist who may use cyclopentolate 0.5% in both eyes.

Fundus [6]

- A basic fundus examination can be carried out with the ophthalmoscope. The key to success is practice and a systematic approach. Most commonly used lights are the white and the blue filter. The green filter highlights vessels (and flame haemorrhages) more clearly.
- When examining the patient, explain what you are going to do (including "I'm going to get very close to your face and shine a bright light in your eye. Don't look directly at the light unless I tell you to."). It helps to stand on the side you are going to do the examination.
- Always examine both eyes.
- Your view will be greatly improved by dilating the pupils (**NB**: make sure you have checked the relative afferent pupillary defect (RAPD) first if necessary - see 'Optic nerve function', below). If dilating pupils eyes in the surgery be aware that they will not be able to drive for some time afterwards (this varies with the preparation), as they may experience blurred vision.
- Elicit the red reflex and 'home in' through the pupil, looking for the disc. Adjust the focus until you are happy with what you can see. Look for pallor (optic atrophy) or oedema (blurred margins - papilloedema). Then work your way along each of the four main vascular branches, looking for attenuation, aneurysms or exudates (diabetic eye disease). Look at the background retina - are there any haemorrhages (eg, retinal vein occlusion) or areas of pallor (eg, retinal artery occlusion) or unusual pale patches (eg, chorioretinitis)? Lesions are noted as being a number of disc diameters away (nasally or temporally) from the disc.

- Ask the patient to look at the light to assess the macula which lies about two disc diameters temporally to the disc (it may be seen as a slightly darker area than the surrounding retina, with blood vessels arching over and under it but not on top of it) - this part of the examination should be swift, as it may be uncomfortable. Look for the presence of haemorrhage.
- The foveal reflex is a reflection of bright light of the ophthalmoscope from the foveal pit, appearing as a bright point of light that moves with the movement of the ophthalmoscope. It tends to be brighter in children. Note if the foveal reflex is bright, dull or absent: absence may suggest macular abnormalities such as macular oedema, central serous retinopathy, chorioretinitis or macular dystrophy, although it is often also absent in older patients.

Examination of function[6]

Visual acuity

This essential examination should be carried out on every patient presenting with an eye problem.

Snellen chart

This comprises random letters arranged in rows, decreasing in size in each row. Charts are designed to be read at three or six metres. The number indicated at the side of the row corresponds to the distance at which a normal eye could read that row. For example, the top row (marked 60) could be read by the normal eye 60 metres away. The patient should be tested one eye at a time using their normal distance glasses (or distance portion of their bifocals) and then using a pinhole - you cannot assume that their glasses are of the correct prescription and the pinhole will correct any refractory errors, unless there is media opacity - eg, corneal oedema.

- The reading is recorded as 6/60 - this means that the patient was tested at 6 metres (or equivalent if you used a reversed three-metre chart and a mirror) and was able to read the top row only.
- If they score 6/4 (ie read the lowest row), they were tested at 6 metres but their eyesight was so good that they actually saw what a 'normal' person would usually need to be four metres away to read.

- If the patient is unable to read the top row, try counting fingers (CF) at 1 metre in a well-lit room, then hand movements (HM), then perception of light (PL).
- If the patient sees nothing at all, they are said to be NPL (no perception of light).
- If the patient reads most of a line right but gets one or two wrong at the 12-metre row for example, this is recorded as 6/12-2.
- If they get more than two wrong, assume the patient can only read the line above. Similarly, if they could manage a couple of letters in the line below but not the whole line, it is recorded as 6/12+2.

There are variations of the Snellen chart for patients who are illiterate: capital 'E's are rotated in different directions which the patient has to identify.

Children's visual acuity [7]

Children may use the Sheridan-Gardiner test where they have to match up letters or pictures of different sizes with those presented on a card in front of them.

Very young children are examined by assessing their preferential looking at cards of various pictorial complexity (Cardiff card test) and babies may be assessed by their ability to pick up very small objects such as the 'hundreds and thousands' cake decorations. Infants are watched for tracking of a light source.

A number of other visual acuity tests exist which take other factors into account, such as contrast sensitivity and the crowding phenomenon (where the spacing between the letters affects the acuity) but these are the remit of ophthalmology departments.

Visual fields

The best way to examine these in the primary care setting is with a confrontational visual field test. This requires a co-operative patient and, as it is a comparison with your own visual field, assumes that your own visual fields are within the normal range. There are various ways to carry out this test but the principle is always the same:

- Sit opposite the patient, about a metre apart. Ask the patient to cover one eye and cover your contralateral eye (so that, effectively, your covered eyes are opposite to each other).
- Hold your arm out so that your hand is equidistant between you and the patient and place in one of the four quadrants. "I want you to keep your eye looking into mine and I'm going to test how well it can see out at the edges" - keep reminding the patient to look into your eye or the test is meaningless. Depending on the patient, either instruct them to say how many fingers you are holding up (repeat three or four times for each quadrant) or - for more accurate measurement - use a white hatpin. Progressively work your way in towards the centre. If they see it before you then their fields are better than yours.
- Repeat for the fellow eye, giving time for the patient to rest between the two.

Intraocular pressure (IOP)

This needs to be measured where glaucoma is suspected.

Quick examination

- A very low IOP may manifest itself as a soft eyeball on palpation of the globe over the closed lids and a very high IOP may feel hard. However, this is a very crude measure (notoriously unreliable) and a globe thought to be soft on account of perforation should not be palpated. It is not a substitute for proper tonometry where there is a concern over IOP.

Tonometry

- IOP can be very easily measured using a tonometer (normal readings should be between 10 mm Hg and 21 mm Hg). There are many types of tonometer, most of which make contact with the eye surface, so that the eye is first anaesthetised.
- Goldmann tonometry has long been considered the gold-standard method. It uses a prism pressed against the cornea.

- Non-contact ('puff of air') tonometers were not historically considered to be an accurate way to measure IOP, although they were a fast and simple way to screen for high IOP. However, modern non-contact tonometers correlate well with Goldmann tonometry measurements and are particularly useful for measuring IOP in children and other non-compliant patient groups.

Although tonometry is completely painless, many patients find it very difficult.

Pupillary reactions

These should be tested in a dimly lit room (to avoid pupillary constriction from the room light over-riding that from your torch). Tell the patient to look at a far wall to overcome the accommodation reflex. Use a bright light source directed from below (to avoid the shadow from the nose).

- **Direct response to light**: light directly shone on the eye for three seconds should elicit a prompt pupillary constriction of the pupil. Failure to do so is known as an afferent pupillary defect:
    - If there is also failure of the fellow pupil to constrict, this indicates severe optic nerve pathology (eg, transected nerve).
    - If there is no pupillary constriction to light but the fellow pupil does constrict, consider a traumatic iris paresis.
- **The swinging flashlight test**: this may elicit an RAPD. Shine the light source from one eye to the other in rapid succession. Stimulation of the normal eye should elicit a brisk constriction of both pupils but when the light is shone on the diseased eye, both pupils dilate. This is because the dilatation produced by withdrawing the light from the normal eye outweighs the weak constriction produced by shining light on the diseased eye. It can be difficult to elicit this sign if there are dark irides and sluggish, dilated, or miotic pupils.

- **Light-near dissociation**: if the reactions to light are normal, proceed to the accommodation reflex. The room light should be turned on again and the patient asked to look at a far wall. Tell them that as soon as they see your pen (or other object), they should focus straight on it. As they gaze to the distance, hold your object above the level of their eyes, then drop it into their line of view and observe the pupillary reactions as they look at it . Light-near dissociation means that there is a reduced or absent pupil light response with relative sparing of the accommodation (near) response. Light-near dissociation may be associated with a midbrain lesion.

If all pupillary tests are normal, the patient can be said to have **P**upils **E**qual and **R**eactive to **L**ight and **A**ccommodation (PERLA).

Optic nerve function [8]

There are several essential components to examining the function of the optic nerve:

- Visual acuity.
- Pupillary responses (as above).
- Check for colour impairment (dyschromatopsia). Ideally, this is done using Ishihara pseudo-isochromatic plates: cover the good eye first and flick through the booklet, allowing about five seconds per number, then compare with the fellow eye. If the booklet is not available, ask the patient to look at a bright red object (such as a child's toy) and compare the intensity of the colour when viewed with each eye separately - descriptions of things looking 'washed out' suggest reduced colour vision.
- Assess brightness sensitivity: shine a light in each eye. The light source is held 30 cm from the patient's eye and lined up to be in the centre of the visual axis. It is then swung into the other eye for the same length of time. The patient is asked whether the light was of equal brightness in both eyes. If the patient feels the eyes differ they are asked to allocate a score out of 100 to the less bright eye, if the brighter one scores 100.
- Confrontational field test.

- Assessment of the blind spot: in the same examination position and conditions as for confrontational visual field; bring a bright red object horizontally across the patient's central field of vision, asking them to tell you if/when it disappears and then when it re-appears - if the blind spot is any bigger than yours, examine its margins, moving the pin around until you have an idea of its size.

Macular function [9]

The easiest method of assessing macular function is using an Amsler grid which effectively measures the central 10° to 20° of each eye's visual field. It consists of a piece of paper on which a 10 cm x 10 cm grid box is printed with a black dot in the centre:

- The patient is asked to cover one eye and fix their gaze on the central dot.
- The patient is asked if they can see the four corners of the box. They are then told to comment on any distortions or missing areas within the box. If able to, the patient can draw the areas of distortion on and this provides a record of disease progression.
- This should be repeated for the fellow eye.

This gives a reasonable indication of macular function. This tool can be used by the patient who can self-test at home and report early if changes are detected.

Eyelids [10]

Examination of the function of the eyelids is usually done in the context of assessing a ptosis. Several simple measurements can be made using a transparent ruler with millimetre calibrations:

- The palpebral fissure (PF) - the distance between the upper and lower eyelid in vertical alignment with the centre of the pupil.
- The marginal reflex distance test 1 (MRD-1). This is the distance between the centre of the pupillary light reflex and the upper eyelid margin with the eye in primary gaze.
- MRD-2: this is the distance between the centre of the pupillary light reflex and the lower eyelid margin with the eye in primary gaze.

- Levator function - the distance the eyelid travels from downgaze to upgaze while the frontalis muscle is held inactive at the brow: ask the patient to look down, pressing your finger firmly on the eyebrow as they do so. Put the ruler near the eye and ask the patient to look as far up as possible. Measure the distance covered from down to up gaze by the lid margin. A normal adult value is typically 15-20 mm.
- The margin fold distance: this is the distance from the upper eyelid margin to the fold of skin.
- Assess for lagophthalmos (lid lag): gentle closure results in a residual show of upper sclera as the eye moves from up to downward gaze.
- Examine the pupils for evidence of Horner's syndrome.

Extraocular muscles [11]

- **Eye alignment**: hold a light source about an arm's length away from the patient and look at the position of the light reflection. This is usually in the centre of each pupil. If one side or the other is towards the outer edge, this indicates an inward deviation of the globe (esotropia) and if there is a reflex more towards the inner edge of the pupil, there is an outward deviation of the globe (exotropia).

- Cover testing for squints. The cover test is used to determine both the type of ocular deviation and the amount of deviation. The two primary types of cover tests are:

    - The **unilateral cover test** (or the cover-uncover test): the patient focuses on an object and then you cover the fixating eye and observe the movement of the other eye:

        - If the eye was exotropic, covering the fixating eye will cause an inwards movement.

        - If the eye was esotropic, covering the fixating eye will cause an outwards movement.

    - The **alternating cover test**: the patient focuses on a near object. A cover is placed over an eye for a short moment and then removed while observing both eyes for movement. The misaligned eye will deviate inwards or outwards. The process is repeated on both eyes and then with the child focusing on a distant object. This test is used to detect a latent squint that only manifests itself in the absence of bifoveal stimulation. Most normal people have this to a very mild degree.

An epicanthus or facial asymmetry may mimic a squint.

Eye movement
This examination is necessary in a number of orbital problems (eg, orbital floor fracture) as well as neuromuscular problems (eg, myasthenia gravis):

- Sit the patient in front of you and explain that you want them to follow a bright object with their eyes only and that you will help them keep their head still.

- Gently but firmly place a hand on their forehead and with the other, test all the positions of gaze in that hemifield.

- Swap hands and do the same in the other hemifield. Look for limitation of globe movement, and nystagmus, and ask about diplopia, blurring or loss of the image.

Other tests carried out in the ophthalmology department[12]

Other tests that are routinely performed in specialist units include:

- **Visual field assessment** - using static and kinetic perimeters. Perimetry or campimetry systematically tests the visual field through the detection of the presence of test targets on a defined background. Perimetry maps and quantifies the visual field, especially at the extreme periphery. Automated perimeters are used widely.
- **Ultrasound** - to visualise the structures of lens, vitreous and retina.
- **Exophthalmometer** - to assess proptosis (eg, thyroid eye disease). There are several types of exophthalmometers, some of which measure the distance of the corneal apex from the level of the lateral orbital rim while others measure the relative difference between each eye
- **Keratometry** - this is the measurement of the corneal curvature, which determines the power of the cornea. Differences in power across the cornea result in astigmatism. Keratometry can be done manually or using automated devices. Keratometry allows visualisation of the pre-corneal tear film and a dynamic view of the surface of the cornea and of the tear film. You can recognise areas of corneal surface irregularity or compromise. If the tear film is oily or disrupted, or the cornea has subtle dystrophy or degeneration, it will be reflected in the quality of the measurements.
- **Hess chart** - this maps extraocular muscle movement and assesses diplopia. In the Hess test the patient's left and right eyes see two similar grids superimposed by angled mirrors. They are then asked to point out the grid's intersection points with a marker. In a normal patient, the results would be centred on each chart. Distortion in caused by unco-ordinated movements of the eye muscles.
- **Fluorescein angiography -** this allows the assessor to visualise and map retinal and choroidal vessels and to identify abnormalities.

- **Optical coherence tomography (OCT)** - uses light waves to take detailed cross-section images of the retina. Imaging of retinal layers helps with diagnosis and provides treatment guidance for glaucoma and retinal disease, such as age-related macular degeneration and diabetic retinopathy. The OCT machine scans the eye without touching it, through a dilated pupil. Scanning takes about 5-10 minutes.
- **Visually evoked potential (VEP), also called visually evoked response (VER) and visually evoked cortical potential (VECP)** - this measures electrical potentials, initiated by brief visual stimuli, recorded from the scalp overlying the visual cortex. VEPs are used primarily to measure the functional integrity of the visual pathways from retina via the optic nerves to the visual cortex. Any abnormality that affects the visual pathways or visual cortex can affect the VEP - eg, cortical blindness due to meningitis or anoxia, optic neuritis as a consequence of demyelination, optic atrophy, stroke and compression of the optic pathways. Myelin plaques (found in multiple sclerosis) tend to slow the speed of VEP wave peaks. Compression of the optic pathways reduces amplitude of wave peaks.

Dr Mary Lowth is an author or the original author of this leaflet.

Further reading

- Conjunctivitis - infective; NICE CKS, April 2018 (UK access only)
- Red eye; NICE CKS, October 2016 (UK access only)
- Glaucoma; NICE CKS, November 2020 (UK access only)
- Biousse V, Bruce BB, Newman NJ; Ophthalmoscopy in the 21st century: The 2017 H. Houston Merritt Lecture. Neurology. 2018 Jan 23;90(4):167-175. doi: 10.1212/WNL.0000000000004868. Epub 2017 Dec 22.

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