ACQUIRED COLOUR ANOMALIES

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THIS CHAPTER WILL INCLUDE A REVIEW OF:

- Acquired colour anomalies
- Colour vision in ocular diagnosis

ACQUIRED COLOUR ANOMALIES

We have so far discussed hereditary colour anomalies. Today we will consider acquired anomalies. Review Table 25.1, which lists important differences between hereditary and acquired colour anomalies.

Acquired colour vision anomalies caused by disease or toxicity can produce either red-green or blue-yellow anomalies. Among hereditary colour anomalies, the red-green type are more common, so some people assume that if a person has a red-green anomaly, it is a hereditary, rather than acquired condition. It is important to understand that not all red-green anomalies are hereditary – in some cases patients have red-green defects that are caused by disease.

Since hereditary blue-yellow defects are so rare, you should assume that a patient with a blue-yellow anomaly has acquired it due to some disease, unless proven otherwise.

In addition, anytime you detect a colour vision anomaly that is asymmetric between the two eyes, you should assume it is acquired.

Q. Why should you always test colour vision monocularly?

A. _____

Q. Which eye should you test first?

A. _____

ACQUIRED COLOUR ANOMALIES (CONT.)

Table 25-1: *Comparison of hereditary and acquired colour anomalies*

HEREDITARY	ACQUIRED
Predominantly red-green	Blue-yellow or red-green
Predominantly males	Male or female
Colour naming errors rare	Recent colour naming errors
Stable with time	Variable or progressive
Diagnosis & classification clear-cut	May be difficult to diagnose & classify
No associated disease	Associated disease
Binocular	Monocular or asymmetric

KÖLLNER'S RULE

Traditionally Köllner's rule has been used to help diagnose diseases based on the type of colour anomaly that may be caused by the disease. It is summarized in Table 25.2 below.

Table 25-2: *Köllner's Rule*

	BLUE-YELLOW DEFECTS	RED-GREEN DEFECTS
KÖLLNER'S RULE	Media, choroid, outer retina	Optic nerve, inner retina
EXAMPLES	Cataract, diabetes, RD, macular degeneration, chorioretinitis, central serous retinopathy	Optic neuritis, papillitis, Leber's optic atrophy, toxic amblyopia, visual pathway lesions
EXCEPTIONS	Glaucoma, papilledema	Dominant cystoid macular dystrophy, Stargardt's disease (fundus flavimaculatus)

This rule states that diseases of:

- Outer retina (outer plexiform layer, receptors, RPE) and ocular media cause blue-yellow defects
- Diseases of inner retina (ganglion cell layer, optic nerve) and visual pathways cause red-green defects

ACQUIRED COLOUR ANOMALIES (CONT.)

In practice Köllner's rule is not so useful since there are exceptions and in some conditions, one kind of anomaly can change into another. For example, the blue-yellow channels seem more susceptible, so in certain diseases those defects will appear first, but later the patient can develop red-green defects. See Table 6-4 in Schwartz, 2004.

Some diseases can cause a type of anomalous colour perception known as **chromatopsia**. This is a condition in which vision appears to have a coloured tint, as if the person was looking through tinted lenses. Colour discrimination is normal, and this is different from any of the colour anomalies we discussed previously (protan, deutan, tritan defects). Examples include:

- **Xanthopsia**, or yellow vision – a side effect of some medications
- **Cyanopsia**, or blue vision – Cataracts often have a yellowish tinge since they strongly absorb blue light. Patients with cataracts become accustomed to vision with a reduced blue component, so after cataract surgery they will suddenly begin receiving more blue light, causing cyanopsia. This diminishes with time. This is also reported as side effect of Viagra
- **Erythopsia**, or red vision – Due to snow blindness or atropine use
- **Chloropsia**, or green vision – Due to epinephrine, or lead poisoning
- **Ianthinopsia**, or violet vision – Due to cannabis use

COLOUR VISION IN OCULAR DIAGNOSIS

SHORT WAVELENGTH AUTOMATED PERIMETRY (SWAP)

In glaucoma, retinal neurons are gradually destroyed over time, but since the visual loss proceeds slowly, usually affecting peripheral neurons first, it is essentially a symptomless disease in the early stages. Because of this, early diagnosis is the key to managing glaucoma.

Optometrists use two general strategies to diagnose glaucoma and other diseases.

- They look for signs of disease or damage in the ocular tissues; for example an enlarged C/D ratio. The problem with this approach is that you usually cannot detect pathological changes in the retinal neurons until much damage has already occurred. New instruments such as the HRT (Heidelberg Retinal Tomography), GDx (nerve fiber layer analyzer), OCT (optical coherence tomorgraph) or RTA (retinal thickness analyzer) are allowing doctors to evaluate subtle changes in the retina that previously were too hard to see. Adaptive optics ophthalmosocopy may also improve diagnosis in this way
- The other approach is to measure changes in visual function caused by the disease. The problem is, which visual function should you test? Many different psychophysical tests can be done to evaluate vision, but you prefer to find one that is sensitive to early glaucomatous damage

In the case of glaucoma, it seems that the S-cone/blue-yellow system is more susceptible to damage than the M and L/red-green system. Short wavelength automated perimetry (SWAP) was therefore developed to isolate and test the S-cone system. This is available as an option on the Humphrey Visual Field Analyzer. In SWAP, the background is yellow and is designed to reduce sensitivity of the M and L cones. A blue light is then projected onto the yellow background and the detection threshold is measured.

Spectral Increment Threshold

(Schwartz, 2004 p. 162, 129-131)

Schwartz describes a psychophysical test that can be done to test the colour-opponent parvocellular system (the chromatic system). A faint monochromatic (single wavelength) light is presented on a white background and its threshold for detection is measured. The threshold for many wavelengths is tested, then sensitivity (inverse of threshold) is plotted as a function of wavelength. In normal subjects, the function shows three peaks that correspond to the S, M and L cone contributions. The peak at 440 nm closely matches the peak sensitivity of the S cones, but the peaks at 520 and 620 correspond more with the negative and positive peaks of the red-green opponent systems (Schwartz Fig. 5-14) , rather than the M and L cones peaks (535 and 565 respectively).

In diseases that affect the S cone system, the chromatic function may have a depressed short wavelength peak. Figure 6-2 in Schwartz shows that, in the case of the deuteranope, the middle peak is missing and in a protanope, the long wavelength peak is missing.

COLOUR VISION IN OCULAR DIAGNOSIS (CONT.)

Clinical Colour Vision Screening for Neurological Disease

Several simple clinical colour vision tests, known as "red cap tests" have been designed to roughly test colour vision. These are sometimes used to diagnose diseases such as optic neuritis. These test simply indicate that a person's colour vision is abnormal. They cannot validate that the perception is normal, and in the case of a colour anomaly, they do not diagnose the type or severity.

Red Cap Test I – Binocular Comparison

- Use a red target such as a Tropicamide bottle cap
- Have the patient view the cap monocularly with each eye and compare redness of the cap as seen by either eye
- In the presence of optic nerve disease, the red cap will appear to be less saturated and dimmer to the affected eye

  Conduction defects of the optic nerve, e.g., optic neuritis, typically reduce colour perception. Colour defects may precede or be disproportionally more advanced than changes in visual acuity. [...] In response to the above test, the patient with reduced central acuity due to an optic nerve lesion usually reports that the coloured object is dimmer than when viewed by the normal eye; that is, the colour is desaturated or "washed out" and appears yellow, white or gray. In the absence of pathological change in the fundus, a positive response to this alternate-eye colour comparison test is evidence of an optic nerve lesion. (Duane's Ophthalmology, 2011 Ch. 2, p. 4-5)

Red Cap Test II – Monocular Central-peripheral

- Use two Tropicamide bottles with red caps or other red targets. (Make sure they are exactly the same colour.)
- Hold one cap centrally and the other slightly peripherally (10 degrees).
- Have the patient view the cap monocularly and compare the redness of the central and peripheral red caps.
- Normally the central cap will appear to be more saturated, or redder.

In diseases of the optic nerve, the peripheral cap may appear to be more saturated than the central cap.

Red Cap Test III – Monocular Nasal-temporal

- This test is used to detect temporal visual field defects secondary to chiasmal compression
- Use two Tropicamide bottles with red caps or other red targets
- Hold both bottles on either side of fixation (one nasal, one temporal field), while the patient looks monocularly
- Ask the patient to compare the redness of the two caps
- Normally they should appear to be the same redness
- In the presence of a large visual field defect, the red cap located in the defective field should appear less saturated

A failure on any of these tests should be followed with more formal colour vision testing, visual fields and other tests.

Q. Would these tests be useful for detecting both R-G and B-Y acquired colour anomalies?

A. A tritan should have nearly normal colour perception for long wavelengths (red), so this probably would not detect a patient with an acquired B-Y defect. It would be useful for either a protan- or deutan-type anomaly.

Q. Why would you want to test for possible optic neuritis using a red object? (hint: Köllner's rule)

A. According to Köllner's rule optic nerve diseases can cause R-G anomalies, so it makes sense to test with a red object.

SELECTED READING/REFERENCES

- Schwartz SH. **Visual Perception - A Clinical Orientation, 3rd Edition**. Appleton & Lange, Stamford, Connecticut, 2004
- Duane TD, Tasman W and Jaeger EA. **Duane's Clinical Ophthalmology**. JB Lippincott Co. Chicago. 2011