Binocular vision

Part 4 – Compensation assessment

In the latest in our series looking at binocular vision assessment in practice, Priya Dabasia describes the assessment and management of compensation and decompensation.

Module C15357, one general CET point for optometrists and dispensing opticians

The first part in this mini-series detailed the detection and measurement of heterophoria using the cover test (CT). This article aims to provide an overview of the assessment of heterophoria compensation and management of poorly controlled deviations. Heterophoria occurs when both visual axes are directed toward the fixation point but deviate on dissociation. In the absence of a visual stimulus such as under the closed lid at rest, our eyes have a natural tendency to revert to their resting states by deviating upwards and outwards. During CT, this translates on average as a small esophoria at distance and exophoria at near fixation. A summary of the basic types of heterophoria is shown in Table 1.

Decompensated heterophoria is one of the most common anomalies of binocular vision to present in daily practice. ‘Compensation’ refers to the control of a heterophoria:

- ‘Well compensated’ – fully controlled with no symptoms in the absence of suppression
- ‘Decompensating’ – poor control with symptoms, or where a practitioner deems that lack of treatment is likely to result in a deterioration of binocularity
- ‘Full decompensation’ – complete failure of the vergence system resulting in a breakdown of a heterophoria to a heterotropia. This is highly probable in childhood as a result of the instability of binocular vision, with associated foveal suppression and gradual loss of depth perception.

Panum’s fusional area

For normal binocular single vision, there is a point to point correlation between the eyes in which the fovea of one eye corresponds with a small foveal area of the fellow eye in higher cortical processing. This horizontally oval group of retinal elements is known as Panum’s area, and occurs for every point of the retina, increasing in size with eccentricity from the fovea where it measures 5-10 minutes of arc (Figure 1). For fusion to take place between the eyes, images must either fall exactly on the same points, or slightly disparate elements provided they are located within Panum’s area. This misalignment of one or both visual axes is called fixation disparity (FD) or retinal slip, and is evaluated clinically to provide a measure for the degree of compensation in heterophoria. When the visual system is subjected to such undue stress, the axes slip closer to the limit of Panum’s area – if the misalignment is large enough to fail

| TABLE 1 |
| A summary of heterophoria types, features and causes |

<table>
<thead>
<tr>
<th>Type</th>
<th>Details</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophoria Eye moves nasally under cover</td>
<td>Convergence excess Greater at near than distance</td>
<td>• Anatomical (narrow PD) • Refractive (high hypermetropia) • High AC/A ratio • Weak divergent (negative) fusional reserves</td>
</tr>
<tr>
<td></td>
<td>Divergence weakness Greater at distance than near</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-specific Similar angle at near and distance</td>
<td></td>
</tr>
<tr>
<td>Exophoria Eye moves temporally under cover</td>
<td>Convergence weakness Greater at near, often but not always with convergence insufficiency</td>
<td>• Anatomical (wide PD) • Refractive (myopia, presbyopia) • Weak convergent (positive) fusional reserves • Age</td>
</tr>
<tr>
<td></td>
<td>Divergence excess Greater at distance than near</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-specific Similar angle at near and distance</td>
<td></td>
</tr>
<tr>
<td>Vertical phoria Eye moves up or down under cover</td>
<td>Hyper/hypo One eye rotates upwards and the other downwards under cover</td>
<td>• Refractive (high myopia)</td>
</tr>
<tr>
<td></td>
<td>Alternating hyper/hypo Either eye moves upwards/ downwards under cover</td>
<td>• Weak vertical fusional reserves • Anatomical (abnormal extraocular muscles) • Incomitancy - extraocular muscle anomaly (see Part 2)</td>
</tr>
<tr>
<td>Cyclophoria either eye ‘wheel rotates’ under cover</td>
<td>Incyclophoria Upper end of vertical axis is nasal</td>
<td>• Oblique astigmatism</td>
</tr>
<tr>
<td></td>
<td>Excyclophoria Upper end of vertical axis is temporal</td>
<td>• Incomitancy</td>
</tr>
</tbody>
</table>
beyond, the patient will appreciate physiological double vision (diplopia) in the absence of suppression.

**Causes of decompensation**

The size of a heterophoria does not relate directly with the likelihood of a patient becoming symptomatic – a 2 dioptre hyperphoria can give rise to a multitude of symptoms while a patient can be oblivious to an 8 dioptre exophoria. The causes of decompensation can be attributed to one or more of the following:

- Reduction in fusional reserves – the convergence, divergence and vertical range between the eyes that maintains binocular single vision
- Disruption in fusion of monocular images of each eye
- Exceptionally large amplitude heterophoria
- From a clinical perspective, the practical manifestations of these factors are listed in Table 2.

The main optical cause of decompensation is uncorrected refractive error, arising primarily as a consequence of the relationship between accommodation and accommodative-convergence. A young hyperopic patient without spectacle correction must accommodate to overcome refractive blur; the resulting accommodative-convergence effort induces an esophoric deviation that is greater at near. Similarly, a myopic patient reading unaided lacks the accommodative-convergence to control a near exophoria. The other contributory factor that cannot be corrected is age – as the amplitude of accommodation reduces over time, the average heterophoria at near has been found to increase up to 6Δ at the age of 65 years.

**Symptoms of decompensation**

The difficulty in making a diagnosis based on symptoms alone is that they can be non-specific ranging from general irritation to vertigo/nausea. Unlike in childhood, the increasing stability of the binocular system prevents young adults from adapting to a decompensating heterophoria through suppression, making it increasingly likely that they present with symptoms of:

- Headaches – horizontal heterophoria is associated mostly with a bilateral frontal ache while hyperphoria results in occipital pain
- Asthenopia – eye ache, dull pain behind the eyes and/or general soreness
- Blurring of print and difficulty changing focus to distance following a period of near work – the focusing capability of the eye is affected by the accommodative-convergence induced to control a heterophoria
- Intermittent diplopia usually following a period of intense work
- Intermittent ‘confusion’ or distorted vision – instability in binocular alignment results in the perception of letters or words moving, flickering or jumping so that words/lines of text are missed or patients may even report shapes or patterns on the page
- Less commonly patients describe difficulties in depth perception, particularly during sport
- Adaptation to binocular discomfort by closing one eye to read, or adopting an abnormal head posture to prevent double vision by using the nose to block the image of one eye.

Typically, these symptoms will be absent on waking, arising later in the day with increased visual activity. Patients may report that symptoms alleviate with breaks from work.

**Tests for assessing compensation**

Compensation is evaluated using tests conducted during the course of a routine eye examination, with the addition of a few readily available
associations in addition to ascertaining onset, frequency, alleviating factors, suggestive of decompensation including full details of the presenting symptoms essential for the practitioner to acquire supplementary assessments.

1) History and symptoms – it is essential for the practitioner to acquire full details of the presenting symptoms suggestive of decompensation including onset, frequency, alleviating factors, associations in addition to ascertaining the following:
- General health – whether the patient has had any recent periods of illness or changes to medications
- Visual requirements – any increase in ocular activity with changes in occupation, new leisure activities etc.
- Previous ocular history – any history of binocular vision anomalies including prismatic corrections or orthoptic exercises.

2) Measurement of monocular vs binocular visual acuity – in decompensation, binocular acuity can be worse or only slightly better than the monocular acuity in each eye. This can be evaluated by directing the patient to fixate on the best line of acuity while occluding one eye. On removal of the occluder, the patient is asked to report if the line is perceived ‘better, worse or the same’. When a heterophoria is poorly controlled, it is common for patients to hesitate, blink repeatedly or report diplopia.

3) Cover test (CT) – performed with and without spectacle correction at the patient’s reading distance, VDU distance, 6m and 6m+ to obtain maximal information. Ask the patient to report any appreciation of blur and/or diplopia during the course of the CT. On detecting a heterophoria, your notes should include details of:
- Direction of deviation – it can be purely horizontal, vertical, torsional (cyclo) or a combination
- Angle of deviation – graded as ‘minimal’ (less than 10Δ), ‘moderate’ (25-35Δ) or ‘marked’ (greater than 40Δ)

    - Frequency of deviation – whether it is constant or intermittent, presenting with fatigue or at a particular fixation distance
    - Speed of recovery to binocular fixation – a ‘smooth and rapid’ motion indicates good control with strong fusional reserves, while a ‘slow and jerky’ movement warns the examiner of imminent symptoms if not present already. A grading scale can be used from 1-5 where 1 represents full control and 5 describes a heterophoria readily breaking down to a heterotropia
    - Presence of ‘Hering’s movement’ – observed in large angle phorias on removal of the cover in which both the uncovered and covered eye exhibit a versinal movement, half the amplitude of the total deviation.

Take care not to dissociate the deviation fully with repeated cyclic occlusion of the alternate CT before FD tests for compensation have been performed. For this reason, if you wish to measure the angle of heterophoria for monitoring, it is advised that you leave the prism and without spectacle correction at the patient’s reading distance, VDU distance, 6m and 6m+ to obtain maximal information. Ask the patient to report any appreciation of blur and/or diplopia during the course of the CT. On detecting a heterophoria, your notes should include details of:
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Take care not to dissociate the deviation fully with repeated cyclic occlusion of the alternate CT before FD tests for compensation have been performed. For this reason, if you wish to measure the angle of heterophoria for monitoring, it is advised that you leave the prism CT till later.

4) Refraction – can help to establish the cause of heterophoria as well as providing options for management. A cyclopegic agent is indicated for use in testing young children, particularly on detecting an esophoria likely to be attributed to high hypermetropia.

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**TABLE 2**

A summary of the causes of decompensation of heterophoria

<table>
<thead>
<tr>
<th>Optical</th>
<th>Medical</th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uncorrected refractive error</strong></td>
<td>Poor health, fatigue, worry and anxiety</td>
<td>Increase in ocular activity</td>
</tr>
<tr>
<td>• Esophoria decompensated by uncorrected hyperopia</td>
<td>• Reduces fusional reserves</td>
<td>• Change in occupation</td>
</tr>
<tr>
<td>• Esophoria decompensated by uncorrected myopia</td>
<td>• Reduces amplitudes of accommodation and</td>
<td>• Extended period of work at a</td>
</tr>
<tr>
<td></td>
<td>subsequent accommodative-</td>
<td>particular distance (eg prolonged</td>
</tr>
<tr>
<td></td>
<td>convergence</td>
<td>VDU viewing)</td>
</tr>
<tr>
<td><strong>Over/under corrected refractive error</strong></td>
<td>Traumatic injuries</td>
<td>Poor working environment</td>
</tr>
<tr>
<td>• Reduces the acuity and dissociates the eyes</td>
<td>• Head trauma can result in temporary or</td>
<td>• Reading at too close a distance</td>
</tr>
<tr>
<td></td>
<td>permanent reduction in fusion</td>
<td>for long periods</td>
</tr>
<tr>
<td><strong>Poorly fitted spectacles</strong></td>
<td>Adverse effects of drugs</td>
<td>Playing games</td>
</tr>
<tr>
<td>• Particularly with high refractive errors that can induce unwanted</td>
<td>• Certain antihypertensive and antidepres-</td>
<td>• Video games that involve rapid,</td>
</tr>
<tr>
<td>prismatic effects</td>
<td>sant agents can reduce accommodation</td>
<td>repeated pursuit fixation</td>
</tr>
<tr>
<td></td>
<td>• Alcohol has been found to reduce</td>
<td>movements</td>
</tr>
<tr>
<td></td>
<td>horizontal fusional reserves</td>
<td>• ‘Magic Eye’ 3D autostereograms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>that dissociate and disrupt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>accommodation and convergence</td>
</tr>
<tr>
<td><strong>Anisometropia</strong></td>
<td>Short period of occlusion</td>
<td>Night driving</td>
</tr>
<tr>
<td>• Difference in image size between the eyes (aniseikonia) makes</td>
<td>• Patch worn over one eye following a</td>
<td>• Reduced visual information</td>
</tr>
<tr>
<td>fusion difficult</td>
<td>corneal injury</td>
<td>prevents binocular functioning</td>
</tr>
<tr>
<td></td>
<td>• Patch worn in childhood for the treat-</td>
<td>between the eyes</td>
</tr>
<tr>
<td></td>
<td>ment of amblyopia</td>
<td></td>
</tr>
<tr>
<td><strong>Extensive visual field loss</strong></td>
<td>Extensive monocular viewing</td>
<td></td>
</tr>
<tr>
<td>• Glaucoma reduces binocular matching between the eyes</td>
<td>• Jewellers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Advanced AMD in one eye</td>
<td>• Watch makers</td>
</tr>
</tbody>
</table>

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Figure 2 Set-up for the measurement of fusional reserves with automated phoropter.
5) Fusional reserves – represents the horizontal vergence and vertical range required to overcome a heterophoria. It is measured using a rotating prism or prism bar as follows:
● Ask the patient to hold a budgie stick target at a distance of 30cm, fixating on the smallest line of letters discernable by the weaker eye
● Introduce a prism of low power in front of one eye (Figure 2) with the base in the appropriate direction to the fusional reserve under investigation. This may easily be done using an automated phoropter unit. It is advisable to begin by measuring the opposing reserve responsible for controlling the heterophoria – for exophoria you must investigate the convergent reserves and vice versa
● Increase the prism power in small increments giving the patient a few seconds between adjustments to ensure the letters are perceived single and clear
● Ask the patient to report when they are unable to overcome the image blur and record the corresponding prism power as the blur point
● Now reduce the prism power until a clear single image is regained to ascertain the ‘Recovery’
● Repeat the steps above with the prism orientated in the three remaining base directions in turn.

The test can also be performed for distance fixation using a suitable line on a letter chart for fixation. If a patient is unable to appreciate diplopia, an objective measure can be obtained by observing the position of the eye under the prism. Normal values for distance and near fusional reserves are shown in Table 3.

6) Fixation disparity (FD) – evaluated clinically by determining the prismatic or spherical power required to reduce FD to zero, otherwise known as the ‘aligning prism/sphere’ or ‘retinal slip’. In general, symptoms worsen as the amount of aligning prism increases. The most recognised test used since the 1960s can be found on the Mallet unit (Figure 3), a handheld device incorporating an array of near vision tests and assessments for binocular function (see later for Table 3).

<table>
<thead>
<tr>
<th>Base direction</th>
<th>Fusional reserve (Δ)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Near fixation (30cm)</td>
</tr>
<tr>
<td>Out (convergent)</td>
<td>30-35</td>
</tr>
<tr>
<td>In (divergent)</td>
<td>12-14</td>
</tr>
<tr>
<td>Up (infravergence)</td>
<td>2-4</td>
</tr>
<tr>
<td>Down (supravergence)</td>
<td>2-4</td>
</tr>
</tbody>
</table>
procedure). Alternative tests for FD are commercially available, but tend to differ in the presence and degree of visual information identical to each eye (binocular lock) generating variable results.

7) Foveal suppression – young children have the ability to adapt to a large untreated heterophoria by suppressing the foveal image of one eye, while the remainder of the binocular field remains normal. This test is particularly indicated where a large deviation is present without any of the expected symptoms of decompensation, or subjective appreciation of FD. Such a test is integrated in the Mallet unit comprised of five rows of letters arranged in vertical bars so that the central letters are perceived binocularly and the letters to either side by one eye only when viewed through cross polarised filters at a distance of 35cm. A small suppression area is indicated when the patient fails to read the letters to one side of the binocular lock. The size of the zone can be recorded from 20 to five minutes of arc.

8) Near point of convergence (NPC) – convergence insufficiency is indicated with a reading of more than 10cm, often presenting with convergence weakness exophoria.

9) Amplitude of accommodation and AC/A ratio – provides useful information for management given the association between accommodation and convergence.

10) Stereopsis – reduced depth perception (typically less than 100 seconds or arc) can provide an indirect measure of foveal suppression.

**Fixation disparity (Mallet unit)**

The Mallet unit FD test is comprised of two small markers in the form of green strips, located above and below the ‘X’ of an ‘OXO’ target. Coloured strips are easier for the patient to differentiate from the OXO panel which provides the binocular fusion lock required to mimic natural viewing; the choice of green means they are less easily suppressed (Figure 4). The presence or absence of FD is indicated by the subjective appreciation of the relative positions of these strips, viewed through cross polarised filters to ensure that only one strip is perceived by each eye. Vertical nullius strips are used to detect horizontal FD, while horizontal markers evaluate vertical FD. Older versions of the unit have two separate targets accordingly while newer models use a single panel with four radiating strips. The markers and central panel are illuminated internally, while the surrounding text requires an external light source set at a distance of 10 inches. This also stimulates paramacular and peripheral fusion in normal binocular viewing by adjusting for the reduction in illuminance through the Polaroid visor.

Before you begin, ensure that the patient is adjusted for near viewing with the appropriate spectacle correction and reading addition as required. Familiarise yourself with the polarisation of the visor so that you recognise which eye views each strip. It is inadvisable to confirm this by relying on the patient’s subjective response on occlusion of each eye, as it risks dissociating binocularity potentially breaking a heterophoria down to a heterotropia. In standard British units the top and right strips are seen by the left eye and vice versa. Then follow the steps below:

1) Ask the patient to hold the unit at their normal reading distance and angle of viewing; this can be measured using the retractable tape incorporated within the housing.

2) Direct the patient to fixate on the OXO panel and vertically illuminated markers, and ask them to report whether the two strips appear in a straight line above and below the X. Rarely, patients can report a true misalignment but in the majority of cases this identifies unreliable patients, or improves the appreciation of the smallest misalignment by comparing their position when viewed through the visor.

3) Position the cross-polarising visor before the eyes.

4) Ask the patient if they still see two strips:
   - If both strips are perceived, proceed to Step 5
   - If one strip disappears, it is likely that the image of one eye is being suppressed at the cortical processing stage, rendering the test unsuitable for continued use? The test cannot be continued and you are advised to annotate your records accordingly eg R suppression.
   - Temporary disappearance or ‘flashing’ of the strips could be attributed to intermittent suppression or a cortical phenomenon known as ‘retinal rivalry’ or ‘binocular instability’.

NB When both strips are seen, do not assume that suppression is not present as it can occur over a smaller area detected using the foveal suppression test.

5) Direct the patient to read 2-3 lines of the text surrounding the FD target to stabilize binocular viewing. This step is frequently missed wasting invaluable time attempting to align a disparity that is not strictly present.

6) Again ask the patient if the 2 strips are in a straight line above and below the X. If the strips temporarily disappear such as in intermittent suppression, ascertain whether they align at the moment when both strips are present. If both strips are aligned, repeat steps 2-6 using the horizontal markers to evaluate vertical slip.

7) Misalignment can be monococular or binocular in which one or both strips move out of line respectively. The former is an excellent indicator for ocular dominance as it identifies the non-dominant eye for management. You can now use prisms to correct the slip as follows:
   - Crossed FD – the top strip seen by the left eye is perceived to the right of the X and vice versa associated with an exophoria corrected with Base in prisms
   - Uncrossed FD – the top strip seen by the left eye is seen to the left of the X and vice versa associated with an esophoria corrected with Base out prisms
   - Vertical FD – if the left strip is seen by the right eye and is reported higher than the X, it is associated with uncompensated left hyperphoria corrected with Base up prisms before the right eye and Base down in front of the left, and vice versa
- Cyclo FD – indicated by ‘sloping’ of one or both strips, frequently presenting secondary to a vertical deviation. Any residual cyclo slip is assessed by rotating the target so that the strips are perpendicular to their original orientation.

If a vertical disparity coexists with horizontal slip, it is advisable to begin by correcting the latter as in practice a vertical deviation is often the secondary presentation. Possible outcomes of the FD test and the interpretation of results using a standard British unit is tabulated in Figure 5.

Begin with a low powered prism of 0.5Δ and increase incrementally as required, taking care to stabilize binocular viewing between adjustments by asking the patient to read the surrounding text. Record the weakest prism power required for precise alignment (eg Near FD – 2Δ base in R/ no vertical slip)

In younger patients with ample accommodation, spherical lenses can be used to align horizontal slip and control the heterophoria by manipulating the accommodation-convergence relationship:
- Exophoria with crossed FD – requires negative spheres to induce

<table>
<thead>
<tr>
<th>Observation</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="0x0" alt="Diagram" /></td>
<td>No horizontal FD/slip</td>
</tr>
<tr>
<td><img src="0x0" alt="Diagram" /></td>
<td>Deep central suppression R</td>
</tr>
<tr>
<td><img src="0x0" alt="Diagram" /></td>
<td>Left ‘crossed’ slip with uncompensated exophoria</td>
</tr>
<tr>
<td><img src="0x0" alt="Diagram" /></td>
<td>Right and Left ‘uncrossed’ slip with uncompensated esophoria</td>
</tr>
<tr>
<td><img src="0x0" alt="Diagram" /></td>
<td>L vertical slip with uncompensated R hyperphoria</td>
</tr>
</tbody>
</table>

*Figure 5 Possible results of the FD test and their interpretation*
accommodative-convergence
● Esophoria with uncrossed FD – requires positive spheres and/or extra bifocal addition to relax accommodative-convergence.

8) Repeat steps 2-7 for distance viewing stabilising binocular viewing using an appropriate line on the letter chart.

Management of decompensated heterophoria
The presence of FD does not always warrant treatment but is indicated when a heterophoria is symptomatic, asymptomatic with foveal suppression or likely to decompensate and degrade binocularity in due course. When left untreated in young children, suppression can deepen developing into amblyopia. The first stage of management is to remove the cause of decompensation such as environmental factors that are unfavourable to comfortable binocular viewing. Advise reading at a greater distance, regular breaks with VDU work or adjustments to the contrast and/or lighting of visual tasks accordingly. You may also need to address any general health issues by referring the patient to their GP. Next, consider options to provide two similar images for fusion, increase fusional reserves and/or reduce the size of a deviation as follows:

1) Correct the refractive error – required to create two clear, equally sized images for binocular fusion. Even small corrections otherwise deemed clinically insignificant can improve control. In significant anisometropia, contact lenses may provide a better alternative to reduce the aniseikonia and facilitate fusion accordingly.

2) Modification of refractive error – alters the accommodative-convergence by applying a negative add in exophoria and positive add in esophoria as follows:
   ● Hyperopic esophoria – full correction with extra +0.25DS and bifocal addition as required
   ● Hyperopic exophoria – under-correction as required
   ● Myopic esophoria – under-correction by 0.50DS
   ● Myopic exophoria – overcorrection if ample accommodation by no more than –3.00DS, gradually reducing this power over months to allow fusional reserves to be exercised accordingly.

3) Orthoptic exercises – only a feasible option with cooperative patients that fully comprehend the reason for treatment which is usually administered over an intense period of 2-3 weeks. The principle is to improve oculomotor control and re-establish accurate muscle coordination rather than to solely increase fusional reserves. Their use is limited in vertical deviations and larger horizontal heterophorias such as esophoria and exophoria greater than 10Δ and 15-20Δ respectively.
   ● Esophoria – requires improvement of negative relative convergence with stereograms, bar reading and fusional reserve exercises with base in prisms
   ● Exophoria – requires improvement of positive relative convergence and binocular convergence with stereograms, fusional exercises and base out prisms.

4) Prisms – effectively reduce the angle of heterophoria remaining for the patient to control, with particular usefulness in vertical deviations. They also provide an option when exercises fail or are simply impractical given the patient’s age or poor health, and temporary relief for eg students with imminent exams. There is no hard and fast rule when it comes to deciding on prismatic correction, but you may find the following guidelines useful:
   ● Issue half the angle of deviation in dioptres to allow fusional reserves to develop
   ● Use the weakest prism to align markers of the FD test
   ● In strong ocular dominance with monocular slip, prism should be issued for this non-dominant eye. Larger prisms may be divided between the eyes but distributed unequally with the weaker power before the dominant eye.
   Before the final prescription is issued, confirm subjective appreciation of comfortable control using the near/distance letter chart and repeat the CT with this prismatic correction to observe the rapid, smooth recovery to binocular fixation on removal of the cover.

5) Surgery – usually involves weakening one muscle and strengthening another to reduce the angle of heterophoria. It is often the only feasible option in cyclophoria, vertical phorias or unusually large horizontal phorias.

6) Botulinum Toxin A – can be used in the management of large horizontal heterophoria by temporarily reducing the angle of deviation. It does however require repeated injections to maintain comfortable control.

Computerised tests for compensation
The Test Chart 2000 and Near Chart 2000 were originally developed by Professor Thomson of City University in the mid 90s. Newer additions to the product range include Vision Screener programs for schools and more recently the iChart 2000 designed for use with iPhone and iPod touch devices. All these applications integrate a FD test to assess heterophoria compensation based on the original Mallet unit design, thereby following a similar procedure. Research indicates a good correlation between the tests, largely attributed to the choice of binocular lock highly conducive to natural binocular viewing. The monocular markers are viewed with each eye using a visor comprised of red and green filters in front of the right and left eyes respectively (Figure 6). For practitioners who do not feel as comfortable using coloured filters, the revised Test Chart 2000 Xpert uses cross-polarised filters with an additional target of red markers around a central white cross. The software also includes the following supplementary tests:
   ● Associated phoria test – provides a measure of the actual size of FD rather than the prism/spherical power required to overcome it
   ● Suppression tests – including ‘Worths 4 dot’ test, ‘Traffic lights...
suppression’ test and the ‘Binocularity’ test (iChart 2000) comprised of lines of five letters of reducing size following a similar procedure to the Mallet unit foveal suppression test.

● Stereopsis – random dot stereogram test consisting of red and green dots viewed monocularly through red/green filters in which the illusion of depth is created by a disparity in certain areas.

It is clear from this article that the evaluation of heterophoria compensation is based not on a single measure but a caveat of tests yielding significant information of binocular functioning and indeed a patient’s general health. The tests are simple but effective diagnostic tools which are relatively easy to learn, but must be used regularly to maximise practitioner skill and confidence. It is therefore important that clinical staff familiarise themselves with the battery of tests at their disposal, and know how to interpret the results in order to best serve the interests of the patient.

● The final article in this series considers tests for retinal correspondence and other useful measures of binocularity recommended for daily practice.

References
www.thomson-software-solutions.com

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