Optometric Grading Scales
For use in everyday practice

Richard Pearson describes the Optometric Grading Scales, which combine several separate grading schemes already in use.

Grading schemes for the assessment of contact lens-related complications have been available for several years. The best-known are those of Efron\(^1\) and the CCLRU\(^2\). Described as “a useful adjunct to practitioners in gauging and monitoring the progression of ocular complications in contact lens wear”, they have been advocated for routine use\(^7\).

Using such scales, it has been shown that non-optometrists are capable of making similar, but less reliable, estimates that non-optometrists are capable of with training\(^5\). In view of the proven reliability improves with experience but not with training\(^5\).

The Optometric Grading Scales presented here are an attempt to correct this omission by bringing together for the first time several separate grading schemes already in use.

The Optometric Grading Scales are arranged under the following four headings:

- Limbal anterior chamber depth
- Age-related cataract
- Vertical cup/disc ratio
- Retinal vessels

### Limbal anterior chamber depth

Anterior chamber depth should be assessed routinely, particularly in patients suspected of having glaucoma and those who require pupil dilation. The circumstances which warrant the use of a mydriatic are familiar to every optometrist\(^7\). The van Herick method, which requires the use of the slit lamp biomicroscope, has been widely adopted by optometrists as a method of assessing limbal anterior chamber depth\(^7\).

A pen torch can also be used in what is known as the penlight, flashlight or oblique illumination test. The penlight is held parallel to the plane of the iris and temporally in order to direct light nasally. If the entire iris appears to be illuminated, the inference is that the angle of the anterior chamber is wide open (Grade 4). The presence of a shadow nasally signifies shallowness of the anterior chamber, the degree depending upon the extent of the shadow (Grades 3 to 1). The presence of a crescentic shadow in shallow anterior chambers has prompted some authors to describe this as the ‘eclipse test’\(^8\). van Herick et al considered that this method of estimating angle width was reliable in the majority of cases\(^7\). Since this test takes only seconds to complete, it can easily be undertaken together with the van Herick test.

Both the van Herick and penlight tests assess limbal anterior chamber depth in contrast to axial anterior chamber depth, which can be measured with a simple slit lamp method\(^9\)\(\text{-}\)\(^1\)\(\text{1}\), by means of a pachometer (such as the Haag-Streit model II) or using A-scan ultrasoundography\(^\text{1}\)\(\text{1}\)\(\text{2}\)\(\text{3}\)\(\text{4}\). Table 1 shows the results of several studies of the sensitivity and specificity of the van Herick and penlight tests. The variation in results may be due to the different patient populations (numbers, ethnicity, etc) and the use as the ‘gold standard’ of pachymetry in some studies\(^3\)\(\text{5}\)\(\text{6}\) and gonioscopy in others\(^7\)\(\text{-}\)\(1\)\(\text{1}\)\(\text{1}\)\(\text{1}\).

Grading schemes generally use an increasing numerical value to correspond to greater levels of severity of a condition, and these are usually illustrated from left to right. The van Herick and penlight tests are unusual in that the ‘least severe’ situation is described as Grade 4 and most severe situation as Grade 1. In an attempt to reconcile this situation on the Optometric Grading Scales, decreasing depth of the anterior chamber is arranged from left to right while retaining the numerical values assigned by van Herick et al\(^7\).

It is relevant to note that van Herick et al found that only 1.64% of 2,185 subjects examined by slit lamp and gonioscopy were classified as having narrow angles (Grades 1 or 2)\(^7\). It is also reassuring to note that none of the 4,870 Caucasian and Afro-Caribbean subjects who were dilated developed angle-closure glaucoma, despite the fact that 38 of them were judged on the basis of gonioscopy to have occludable angles\(^1\)\(\text{1}\)\(\text{1}\). Nevertheless, the authors of this study acknowledged that their findings might not apply to an Asian population, in which angle-closure glaucoma is reportedly more common.

Reference to the illustrations of the van Herick and penlight procedures should encourage consistency in estimation of limbal anterior chamber depth.

### Age-related cataract

Optometrists monitor various forms of cataract over long periods of time and it has been standard practice to make a sketch of the condition at each examination. It is possible to grade cataract, and reference to the literature suggests that the scheme which currently has the widest acceptance is the Lens Opacities Classification System (LOCS) introduced by Chylack et al in 1988\(^1\)\(\text{9}\).

Initially, the LOCS used black and white photographs for the classification of cortical and posterior sub-capsular cataracts and a coloured photograph for the classification of nuclear colour and opalescence. This system subsequently evolved into LOCS II\(^1\)\(\text{0}\) and LOCS III\(^1\)\(\text{1}\) in which each type of cataract is illustrated with colour photographs.

The drawings used for the classification of age-related cataract in the Optometric Grading Scales are based upon LOCS III photographs and are not intended to replace sketches made by the practitioner, but to complement them by allowing them to be graded. Those

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Text continued on page 42
## OPTOMETRIC GRADING SCALES

### LIMBAL ANTERIOR CHAMBER DEPTH

<table>
<thead>
<tr>
<th>Grade 4</th>
<th>Grade 3</th>
<th>Grade 2</th>
<th>Grade 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Van Herick</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamber ≥ section</td>
<td>Chamber = $\frac{1}{4}$ to $\frac{1}{2}$</td>
<td>Chamber = $\frac{1}{4}$ section</td>
<td>Chamber &lt; $\frac{1}{4}$ section</td>
</tr>
<tr>
<td><strong>Penlight</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO shadow</td>
<td>$&gt;\frac{2}{3}$ illuminated</td>
<td>$\frac{1}{3}$ to $\frac{2}{3}$ illuminated</td>
<td>$&lt; \frac{1}{3}$ illuminated</td>
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</tbody>
</table>

### AGE-RELATED CATARRACT

<table>
<thead>
<tr>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
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</thead>
<tbody>
<tr>
<td><strong>Nuclear</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cortical</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Posterior Sub-capsular</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
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<td></td>
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## OPTOMETRIC GRADING SCALES

### VERTICAL CUP/DISC RATIO

<table>
<thead>
<tr>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
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<td><img src="image6" alt="Cup/Disc Ratio 0.6" /></td>
<td><img src="image7" alt="Cup/Disc Ratio 0.7" /></td>
<td><img src="image8" alt="Cup/Disc Ratio 0.8" /></td>
<td><img src="image9" alt="Cup/Disc Ratio 0.9" /></td>
<td><img src="image10" alt="Cup/Disc Ratio 0.95" /></td>
</tr>
</tbody>
</table>

95% confidence limit of normality
Vert disc diam (mm) C/D ratio
1.2 0.5
1.5 0.6
1.8 0.7
2.2 0.8

(Garway-Heath et al 1998)

### RETINAL VESSELS

<table>
<thead>
<tr>
<th>A/V ratio</th>
<th>100%</th>
<th>80%</th>
<th>60%</th>
<th>40%</th>
<th>20%</th>
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<tr>
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<td><img src="image13" alt="A/V Ratio 0.6" /></td>
<td><img src="image14" alt="A/V Ratio 0.4" /></td>
<td><img src="image15" alt="A/V Ratio 0.2" /></td>
<td><img src="image16" alt="A/V Ratio 0" /></td>
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<tr>
<td><img src="image17" alt="A/V Ratio 0%" /></td>
<td><img src="image18" alt="A/V Ratio 0.25" /></td>
<td><img src="image19" alt="A/V Ratio 0.5" /></td>
<td><img src="image20" alt="A/V Ratio 0.75" /></td>
<td><img src="image21" alt="A/V Ratio 1" /></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Arterial reflex</th>
<th>0%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>100%</th>
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</thead>
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<tr>
<td><img src="image22" alt="Arterial Reflex 0" /></td>
<td><img src="image23" alt="Arterial Reflex 0.25" /></td>
<td><img src="image24" alt="Arterial Reflex 0.5" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Tortuosity</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
<tr>
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<td><img src="image28" alt="Tortuosity 0.1" /></td>
<td><img src="image29" alt="Tortuosity 0.2" /></td>
<td><img src="image30" alt="Tortuosity 0.3" /></td>
<td><img src="image31" alt="Tortuosity 0.4" /></td>
<td></td>
</tr>
</tbody>
</table>

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depicting nuclear cataract illustrate increasing density of opacification but do not, of course, allow grading of its colour. Colour slides and photographs can be purchased from the principal author of LOCS III, Dr Leo Chylack, and are clearly essential for use in cross-sectional or longitudinal research studies.

**Vertical cup-to-disc ratio**

In 1921, Pickard was perhaps the first to mention comparison of the size of the optic disc and cup in relation to glaucoma. It has been said that one of the best established methods of screening for and detecting the early signs of open-angle glaucoma is examination of the optic disc. More recently, it has been stated that clinical estimation of the size of the cup remains the simplest and most frequently performed assessment of the disc in the diagnosis and follow-up of the glaucoma suspect.

If the recorded cup/disc ratio (CDR) is to have clinical value, it is essential that it be estimated consistently both by different individuals and by each individual over periods of time.

Intra-observer agreement has been found to be higher than inter-observer agreement in the assessment of CDR from stereoscopic optic disc photographs, and the inter-observer agreement of ophthalmologists was higher than that of optometrists.

In order to facilitate estimation of the size of the optic disc and cup, the use of a chart comprised of concentric circles to represent cup/disc ratios from 0.1 to 0.9 in intervals of 0.1 was advocated as long ago as 1959. A template of similar construction, but in the form of a transparent sheet, has been used to measure the CDR from colour photographs of the optic disc.

In 1971, Allergan Pharmaceuticals published a Cup Disc Ratio Guide which illustrated values from 0.0 to 0.8, in 0.1 intervals. Despite the use of colour photographs, the potential value of this chart was undermined by the fact that each small figure was not confined to the area of the disc but included an extensive area of normal retina.

An alternative approach has been the incorporation of a graticule for the evaluation of CDR in direct ophthalmoscopes, such as the Keeler Practitioner and Professional models.

The CDR chart in the Optometric Grading Scales is intended to achieve a more accurate representation than that provided by diagrams of concentric circles, and is novel since it is based upon the data of Jonas et al and constructed using the Burek algorithm. Accordingly, the disc has the shape of an oblate ellipse and for CDR values from 0.1 to 0.5, the cup can be recognised as having the shape of a prolate ellipse. At higher ratios, the cup increasingly assumes an oblate shape. Vertical CDRs are depicted since the cup tends to enlarge in that meridian in glaucoma. One study has demonstrated a significant correlation between the extent of cupping and the size of the visual field, and that the vertical CDR is the most useful quantitative index of cupping.

The margin of the cup is depicted as a dotted line to acknowledge the fact that it is sometimes less easily distinguished than that of the disc. It should be emphasised that the cup margin represents a discernible change in contour, not pallor.

Jonas et al provided data on the variation in width of the neuroretinal rim, reporting that it was greatest inferiorly followed, in decreasing order, by superior, nasal and temporal regions. This finding has been referred to as the ISNT rule, which may be an inappropriate designation in view of the significant standard deviations for the data on rim width.

In subjects with normal optic discs, the mean value of the maximum difference in neuroretinal rim width was 0.2mm. These authors examined the relationship between the total neuroretinal rim area and optic disc area but they provided no information about meridional variation of neuroretinal rim width for different cup/disc ratios. Accordingly, this feature has been omitted in the CDR diagrams in the Optometric Grading Scales. It is, nonetheless, important to assess the neuroretinal rim and to note notching or changes in shape.

When recording the CDR, it is pertinent to recall that Afro-Caribbean subjects have been found to have higher values and a greater prevalence of ratios of 0.5, or more, than Caucasians. Due to the variation in cup size in the normal population, the CDR alone has limited value in the identification of a glaucomatous optic disc. Indeed, the vertical CDR can be as high as 0.85 in normal eyes. Ideally, the CDR should be considered in relation to optic disc size because when this is larger, the cup is correspondingly larger. Optic disc size can be measured using indirect slit lamp biomicroscopy with a high plus-powered condensing lens (e.g. 78 or 90D).

The CDR chart includes a table showing the 95% confidence limits of normality for several vertical ratios and disc sizes, which was compiled using the linear regression equation of Garway-Heath et al.

**Retinal vessels**

It has been common practice to record the relative calibre of retinal arteries to veins as an A/V ratio expressed as a fraction. As long ago as 1890, Gowers remarked that, “As a rule the width of the artery is about two-thirds or three quarters that of the vein” and optometric case records are frequently annotated with “A/V 2/3”.

The preponderance of this recorded value may be due to the fact that the majority of optometric patients exhibit ‘normal’ retinal vasculature. There may, however, be some difficulty in envisaging alternative fractions – a problem which can be obviated by reference to a range of illustrations.

In order to improve description of retinal vasculature, Wolffsohn et al used diagrams of the artery-to-vein ratio expressed as a percentage. Although the range of their grades was from 120% to 40%, the upper limit encountered in their subjects was 100%. In view of this finding, the Optometric Grading Scales illustrate A/V grades from 100% to 20%.

Grades depicting the width of the arteriolar reflex and arteriolar tortuosity have also been included, since these have been shown by the same authors to be particularly useful indicators of systemic hypertension. Photographs of normal and congenitally ‘abnormal’ vessels served as models for the two extremes shown in the diagrams depicting tortuosity. Intermediate grades were derived by manipulation of the images in digital form.

**Conclusion**

As with contact lens grading scales, it is of course possible to optimise grading sensitivity by interpolating between the grades illustrated. The Optometric Grading Scales are presented in the hope that they will minimise intra and inter-observer variation in the assessment of various clinical features.

**Acknowledgement**

The author is indebted to Henry Burek, who devised the algorithm for the construction of the CDR chart.

**About the author**

Having worked in multiple, independent and hospital practice, Richard Pearson has spent most of his career in optometric education.

**References**

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