LETTERS TO THE EDITOR

Calculation of the optic disc and cup area by the minimal and maximal diameters

EDITOR,—Quantification of optic disc morphology, particularly the neuroretinal rim area, has increasingly been recognised to be of importance in the diagnosis of anomalies and diseases of the optic nerve. This is especially true in glaucomatous optic neuropathy.[1 2] The area of the neuroretinal rim is usually determined by measuring the disc and cup areas planimetrically using photographs, by sophisticated videographic techniques or by scanning laser ophthalmoscopy.[1-3] The rim area is then calculated as the difference between the disc and cup areas. It has recently been suggested that the disc and neuroretinal rim areas might be estimated clinically by applying geometric formulas to linear diameter measurements of the disc and cup made during indirect ophthalmoscopy.[4 5] This simple and inexpensive technique relies on an approximation which considers both the disc and cup to be regular ellipses. We have performed this study to determine the magnitude of error that this approximation might introduce.

Sequential stereo colour optic disc diapositives of 1171 normal eyes and of 2635 eyes with glaucoma were included in the study. In each case the disc and cup areas were measured planimetrically and linear measurements were made of the maximal and minimal diameters of both disc and cup.

The optic disc was defined as the area within the peripapillary scleral ring while the optic cup was defined on the basis of contour rather than colour. To obtain the measurements in absolute size units – that is, mm or mm^2 Littmann's formula was used to correct the magnification of the Zeiss fundus camera and the ocular magnification. We compared the area measurements obtained planimetrically with those estimated from the formula:

$$\text{Area} = (\pi \times \text{maximal diameter} \times \text{minimal diameter})/4$$

For each case the error was determined as the difference between the values obtained by the two methods divided by the average of the two methods.

In the normal group, the mean errors for the areas of the optic disc and cup, respectively, were 1·1% (SD 1·1%) and 1·6% (2·0%), respectively. Similar values were found for the glaucoma group (Table 1). The mean error for the neuroretinal rim area was larger in the glaucoma group (5·5% (16·4%)) than in the normal cohort (1·8% (2·0%)). It increased significantly with decreasing neuroretinal rim area ($p<0.0001$). The regression line had an exponential form with a steep increase for the small neuroretinal rim areas. Correspondingly, in glaucoma eyes with a neuroretinal rim area larger than 0·40 mm^2, the error for the rim area was 3·9% (4·7%) (median 2·4%). Generally, the errors were smaller in eyes with a regular disc shape than in eyes with an irregular form of the optic nerve head as indicated by an oblique orientation of the maximal disc diameter and a low ratio of the minimal to the maximal disc diameter.

The results indicate that for clinical disc biometry the optic disc, cup, and neuroretinal rim areas can be determined using the values of the minimal and maximal diameters and the formula of an ellipse. The resulting error is smaller for eyes with a regular optic disc shape than for eyes with an irregular disc form. For the optic disc it measures in the normal and glaucoma group 1·1% on an average. The mean error for the neuroretinal rim area is 1·8% (2·0%) for normal eyes and 5·5% (16·4%) for eyes with glaucoma. In glaucomatous eyes the error increases as neuroretinal rim decreases. This may be due to the decreasing size of the denominator in the equation 'difference between the values obtained by the two methods divided by the average of the two methods'. In the early stages of rim loss the error is relatively low.

This study suggests that, for clinical purposes, simple linear measurements of the disc and cup are sufficient to allow the neuroretinal rim area to be estimated reliably. It does not determine, however, by which method the diameters and areas of the optic disc and cup should be measured. It remains the purpose of further investigations to evaluate the reasons why the mean optic disc size differs between various methods such as the Heidelberg retina tomograph,[3] the optic nerve head analyser,[2] other planimetric examinations,[1] and the method described by Montgomery.[4 5]

Table 1 Optic disc, cup, and neuroretinal rim determinations

	Normal group (n=1171)	*Glaucoma group (n=2635)*
Refractive error (D)	−0·13 (2·09)	−0·94 (2·95)
Min/max	−7·9/+8·5	−16·1/+8·75
Age (years)	45·6 (16·9)	58·8 (14·7)
Disc area (measured) (mm^2)	2·69 (0·64)	2·74 (0·70)
Disc area (calculated) (mm^2)	2·70 (0·64)	2·75 (0·71)
Difference (mm^2)	0·03 (0·03)	0·03 (0·03)
Min−max (mm^2)	0·0−0·41	0·0−0·38
Error (%)	1·1 (1·1)	1·1 (0·9)
Min−max (%)	0·0−21·7	0·0−11·5
Maximal disc diameter (mm)	1·95 (0·23)	1·98 (0·25)
Minimal disc diameter (mm)	1·74 (0·21)	1·75 (0·22)
Cup area (measured) (mm^2)	0·87 (0·61)	1·67 (0·79)
Cup area (calculated) (mm^2)	0·88 (0·61)	1·69 (0·79)
Difference (mm^2)	0·01 (0·02)	0·03 (0·03)
Min−max (mm^2)	0·0−0·27	0·0−0·38
Error (%)	1·6 (2·0)	1·8 (2·5)
Min−max (%)	0·0−42·5	0·0−50·3
Maximal cup diameter (mm)	1·04 (0·46)	1·54 (0·38)
Minimal cup diameter (mm)	0·89 (0·41)	1·31 (0·34)
Neuroretinal rim area (measured) (mm^2)	1·82 (0·40)	1·06 (0·53)
Neuroretinal rim area (calculated) (mm^2)	1·82 (0·41)	1·06 (0·54)
Difference (mm^2)	0·03 (0·03)	0·04 (0·04)
Min−max (mm^2)	0·0−0·41	0·0−0·43
Error (%)	1·8 (2·0)	5·5 (16·4)
Min−max (%)	0·0−21·7	0·0−448

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Ophthalmoscopic sign of early keratoconus

EDITOR,—Although the diagnosis of early keratoconus is often easy because of visual symptoms and refractive and slit-lamp signs, it can be missed completely in some patients who may have normal visual acuities and almost normal slit-lamp appearances.

In these patients a simple clinical sign (probably first described by Bowman[1] and Knapp[2]) may be useful even today.

If the eye is viewed from about 1 metre through a direct ophthalmoscope a dark central disc or an annular shadow will be seen disturbing the normal red reflex.

This can be compatible with a visual acuity of 6/6 unaided and a normal Placido disc reflection and it is probably as sensitive a test of corneal asymmetry as is corneal topography.

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Survey of the complications associated with current practice of cataract surgery under local anaesthesia

EDITOR,—In July 1993 I sent questionnaires to 500 consultants in England and Wales to inquire into their current practice, particularly the complications they had encountered over their professional life time. The response rate was 66·7%.

Twelve surgeons reported deaths which they felt might have been the result of local anaesthesia. Only 78 surgeons reported that they had encountered what they interpreted as life threatening complications which they felt might have been attributable to local