British Journal of Ophthalmology, 1984, **68**, 212–214

Measurements of axial and peripheral anterior chamber depth: accuracy of a photographic method

R. A. HITCHINGS,[1] J. ROMANO,[1] AND P. CLARK[2]

From the [1]Glaucoma Unit, Moorfields Eye Hospital, High Holborn, London WC1, and the [2]Institute of Ophthalmology, Judd Street, London WC1

SUMMARY The minimum significant ($p=0\cdot05$ level) detectable change noted on measuring anterior chamber depth by a photographic method was found to be 7% either way from the mean. The minimum significant change for a peripheral chamber depth 5 mm from the optic axis was found to be 25% either way.

The dimensions of the anterior chamber may alter with age[1] secondary to the topical application of antiglaucoma drugs[2,3] and following iridectomy in angle closure glaucoma.[4,5] The methods chosen for measuring such changes have been photographic. An earlier method described was that of Jones and Maurice,[6] in which a profile taken of the anterior chamber at an angle of incidence of 45° was projected on to a special grid designed to correct the distortion produced by the corneal curvature. The true outline was then plotted on squared paper, a rather laborious process. The accuracy and ease of making these measurements has been greatly enhanced by the introduction of a transparent grid which can be superimposed over a Polaroid slit-image photograph of the anterior chamber profile.[7] With the use of this grid serial measurements of changes in the anterior chamber profile can be made. Before the grid is used in this way it is important to identify the minimum change which lies outside the errors inherent in making the measurements. This study sets out to estimate such minimum change.

Material and methods

Polaroid slit-image photographs were obtained according to the method of Johnson *et al.*[7] Care was taken to ensure a narrow slit beam which showed both the full corneal thickness and also the anterior lens surface. Care was taken to focus on the angle of the anterior chamber and to avoid excess reflection from the adjacent eyelids. Photographs were taken of the inferior two-thirds of the anterior chamber. Measurements were made of the axial anterior chamber depth and of the peripheral chamber depth 5 mm off axis ('k' on the Johnson grid) (Fig. 1). This

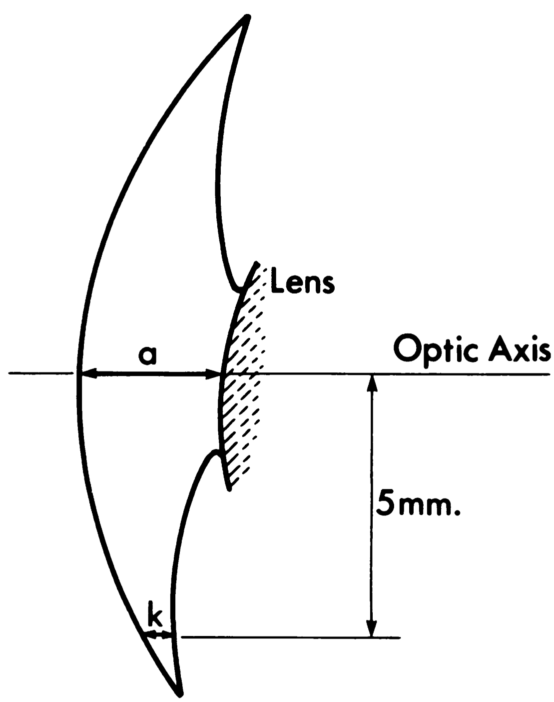

Fig. 1 *Diagram showing position of measurements* 'a' *and* 'k' *on the slit-image photograph of the anterior chamber.* 'a' *is the distance on the optic axis between anterior lens surface and corneal endothelium.* 'k' *is the distance between anterior iris surface and corneal endothelium 5 mm from the optic axis.*

Correspondence to Mr R. A. Hitchings.

particular distance from the optical axis was chosen because an earlier study[5] had shown that the maximum change in the shape of the iris profile occurred here.

Thirty photographs were chosen which fulfilled these criteria. The photographs were marked and numbered. Measurements of axial anterior chamber depth were made by both authors independently and of the 'k' reading by one author (RAH). After this first series of readings the photographs were re-marked and renumbered and the process was repeated. Remasking and renumbering were repeated for a third series of measurements. Thus 90 readings of anterior chamber depths were made by 2 independent observers and 90 readings of 'k' were made by one observer.

Results

Anterior chamber depth for the photographs in this series ranged from 1·5 to 3·7 mm. The 'k' readings for peripheral chamber depth ranged from ≤0·05 (a figure given when the chamber was so shallow that no better level of accuracy could be achieved) to 1·5 mm.

DIFFERENCE BETWEEN THE 2 OBSERVERS

The difference between the readings of the 2 observers was measured, giving 3 differences per eye.

Total number of differences=90.
Mean difference=0·0028 mm.
(Difference=observer 1−observer 2.)

The variance of these differences was calculated as the within-subject variance, that is, the variance of the differences for each eye were calculated separately and these variances were combined for all of the eyes.

Variance=0·0193 on 60 degrees of freedom.
(3 differences for eye gives 2 DF eye.)

A 2-tailed *t* test of whether this mean difference is not equal to zero gives

$$t=\frac{0{\cdot}0028}{\sqrt{0{\cdot}0193/90}} = 0{\cdot}190 \text{ on } 60 \text{ DF}$$

This gives a p value of 0·850 (approximately), that is, there is no statistical difference between the measurements of the 2 observers.

Table 1 *Anterior chamber depth. Minimum difference (mm) between mean of initial and later set of readings required to achieve statistical significance at p=0·05 level*

No. of later readings	*No. of initial readings*		
	3	*5*	*10*
3	0·158	0·142	0·128
5	0·142	0·123	0·106
10	0·128	0·106	0·087

A further check showed that the variance of the readings was not related to their size.

AXIAL ANTERIOR CHAMBER DEPTH

The above results show that it is reasonable to combine the readings of the 2 observers. This gives 6 readings per eye, 180 in all. We can make the following calculations on the data.

Within-subject variance=0·00978.
SD=0·0989.
DF=150 (6 readings per eye gives 5 DF per eye).

To show that the mean of one set of readings is different from another set taken at a later date we can use the following procedures:

Initial readings: let the mean=$\bar{X}$ on nx measurements.
Later readings: let the mean=$\bar{Y}$ on ny measurements.

Assuming both sets of readings have normal distribution with the same variance and hence the same standard deviation, then for a significant difference between $\bar{X}$ and $\bar{Y}$ we need:

$$|\bar{X}-\bar{Y}|>Np^{*}SD^{*}\sqrt{\frac{1}{nx}+\frac{1}{ny}}$$

where Np is the value of the normal statistic for probability level p. (SD is the standard deviation; nx, ny are defined as above; for p=0·05, Np=1·96.)

For these data we can use the within-subject variance calculated above, so that SD=0·0989. This gives:

$$|\bar{X}-\bar{Y}|>1{\cdot}96^{*}0{\cdot}0989\sqrt{\frac{1}{nx}+\frac{1}{ny}}=0{\cdot}1938^{*}\sqrt{\frac{1}{nx}+\frac{1}{ny}}$$

So the difference needed to be regarded as statistically significant at p=0·05 can easily be calculated for different values of nx and ny. For example, nx=ny=3 (3 standard photographs were taken on each patient).

$$\text{We need } |\bar{X}-\bar{Y}|>0{\cdot}1938^{*}\sqrt{\frac{1}{3}+\frac{1}{3}}=0{\cdot}158$$

It should be noted that the larger nx and ny, the smaller the difference needed, given that the variance remains constant (Table 1).

Table 2 *Peripheral chamber depth. Minimum difference (mm) between mean of initial and later set of readings required to achieve statistical significance at p=0·05 level*

No. of later readings	*No. of initial readings*		
	3	*5*	*10*
3	0·129	0·116	0·104
5	0·116	0·100	0·087
10	0·104	0·087	0·071

MEASUREMENT OF CHAMBER DEPTH 'V'

Using the same argument as that used when measuring axial chamber depth we get: within-subject variance =0·00655 with 60 DF (3 readings per eye=2 DF per eye).

SD=0·0809.

To achieve $p<0\cdot05$: $|\bar{X}-\bar{Y}|>1\cdot96+0\cdot0809 * \sqrt{\frac{1}{nx}+\frac{1}{ny}} = 0\cdot1586 * \sqrt{\frac{1}{nx}+\frac{1}{ny}}$

For nx=ny=3 we need $|\bar{X}-\bar{Y}|>0\cdot1586 * \sqrt{\frac{1}{3}+\frac{1}{3}} = 0\cdot129$

Again by varying the size of nx and ny the minimum difference also varies (Table 2).

Discussion

This study has shown that, with the use of a photographic method of estimation, no significant difference existed between the readings of the anterior chamber depth made by 2 observers. For the population sample examined the mean anterior chamber depth was 2·236 mm. The minimum change required to achieve significance at the p=0·05 level was 0·158 mm. This represents a change of approximately 7% either way from this average depth. Similarly the minimum change for peripheral depth was 0·129 mm, which represents a change of approximately 25% either way from the mean figure of 0·518 mm. By using 5 readings each time these figures are reduced to approximately 5·5% and 19% respectively.

References

1 Brubaker RF, Nagataki S, Townsend DJ, Burns RR, Huggins RG, Wentworth W. Effect of age on aqueous formation in man. *Ophthalmology* 1981; **88:** 233–7.

2 Mapstone R. Acute shallowing of the anterior chamber. *Br J Ophthalmol* 1981; **65:** 446–51.

3 Hitchings RA, Powell DJ. Pilocarpine and narrow angle glaucoma. *Trans Ophthalmol Soc UK* 1981; **101:** 214–7.

4 Tornqvist R. Peripheral anterior chamber depth in shallow anterior chamber. *Br J Ophthalmol* 1959; **43:** 169–75.

5 Coakes R, Lloyd-Jones D, Hitchings RA. Anterior chamber volume, measurement and clinical application. *Trans Ophthalmol Soc UK* 1979; **99:** 78–87.

6 Jones RF, Maurice DM. A simple photographic method of measuring the volume of the anterior chamber. *Exp Eye Res* 1963; **2:** 233–6.

7 Johnson SB, Coakes RL, Brubaker RF. A simple photogrammetric method of measuring anterior chamber volume. *Am J Ophthalmol* 1978; **85:** 469–74.