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The Role of White Light Interferometry in Predicting Visual Acuity Following Posterior Capsulotomy

I. T. HANNA, H. SIGURDSSON, P. S. BAINES, S. T. D. ROXBURGH
Dundee

Summary
White light interferometry was performed on 21 eyes of 19 patients presenting for posterior capsulotomy following uncomplicated extracapsular cataract surgery. The white light interferometer was able to predict post-operative visual acuity to within one Snellen line in 56 per cent of eyes and to within two Snellen lines in 76 per cent of eyes.

An intact posterior capsule after extra-capsular cataract surgery is said to decrease major post operative complications such as cystoid macular oedema and retinal detachment.[1,2] However, with time an increasing number of patients develop posterior capsular opacification and will require posterior capsulotomy. The incidence of such posterior capsular opacification is variously reported in the literature at between 12–50 per cent at three to five years, depending on the presence or absence of lens implant or type of implant used.[3,4,5,6]

Posterior capsular opacification therefore represents a significant post-operative problem, not only in terms of patient symptomatology, but also in terms of health care economics.

Surgical posterior capsulotomy has the potential risk of endophthalmitis.[9] However with the advent of YAG lasers for ophthalmic use, it is now possible to divide the posterior capsule without entering the eye, thus negating this risk. YAG laser posterior capsulotomy may however be complicated by lens marking, acute intraocular pressure rise, uveitis, cystoid macular oedema and retinal detachment.[8,9] In view of these complications it is important to assess accurately whether or not patient symptomatology is due to posterior capsular opacification.

We therefore wished to assess one of the commercially available potential acuity meters to see if, in the presence of posterior capsule opacification, it could predict a 'potential visual acuity' and on the basis of this help the clinician in deciding whether or not to perform posterior capsulotomy.

There are three commercially available potential acuity instruments, the potential acuity meter, laser interferometers and white light interferometers. The potential acuity meter of Guyton and Minkowsky[10] projects a representation of the Snellen chart onto the macula by way of a 0.15 beam of white light. Laser interferometers create a grating image within the eye by using two coherent beams of Helium Neon laser light, where as white light interferometers use white incandescent light and produce a large depth of field grating image in the eye.

Correspondence to: Dr I. Hanna, FRCSEd, Department of Ophthalmology, Ninewells Hospital, Dundee DD1 9SY.

From: Department of Ophthalmology, Ninewells Hospital, Dundee DD1 9SY.

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This grating image should theoretically be unaffected by the refractive state of the eye. Furthermore, since the production of the grating image is a function of the amplitude of the electromagnetic wave and not the light beam, partial obstruction of one of the beams should not adversely affect the production of the grating image in the eye.[11] Interferometers would therefore seem to be ideally suited to the assessment of potential visual acuity in patients presenting for posterior capsulotomy after extracapsular cataract surgery, where there is not only a refractive error but also opacity of the refracting media.

White light interferometers are less expensive than laser interferometers and the Site white light interferometer has the added advantage of being a portable hand held device, independent of the slit lamp, unlike other white light devices.

Materials and Methods

In general white light interferometers, such as the Site white light interferometer, use white incandescent light and produce, by the combined effects of diffraction and interference, a large depth of field grating image in the eye, the interference grating being generated by rotating two high spatial frequency gratings which are in contact with each other.[12]

The interference grating is directed into the patient's pupil, and the position of the energy sources in the pupil aperture may be visualised by the observer, thus ensuring that the grating image enters the eye. The instrument has a 'high' and a 'low' intensity setting and the size of the grating image field may be varied continuously from 3 degrees to 8 degrees. The frequency of the grating image may be varied in a steplike manner, the instrument already being calibrated in Snellen equivalents. The orientation of the grating image may be varied continuously in any meridian, thus allowing the examiner to confirm that the subject is seeing the grating image by questioning him as to the orientation of the grating image.

White light interferometry was performed on 21 eyes in 19 patients presenting for posterior capsulotomy. The average age of the patients was 63 years with a range of 58–91 years. All patients had previously undergone uncomplicated extracapsular cataract surgery, seven eyes had surgical posterior capsulotomy performed with Pierce knife via a pars plana approach, and 14 eyes had YAG laser posterior capsulotomy performed with the Lasag Topaz Q switched mono mode laser.

In each eye, an interferometry prediction of potential visual acuity was determined by three of the authors (IH, HS and SR) using the Site white light interferometer. The instrument was used on the 'high' illumination setting with an 8 degree interference grating field. Pupils were dilated with cyclopentolate 1 per cent and the test performed in low ambient illumination, though not in complete darkness. It was found necessary to use low ambient illumination, as it was then possible to observe the energy sources in the patient's pupil aperture thus ensuring that the grating image was being directed into the eye.

The decision to perform posterior capsulotomy was made independently of the interferometry prediction of visual acuity, and in addition the best corrected Snellen visual acuity was determined pre-operatively and again on average 5.5 weeks after capsulotomy.

The total follow up is on average three months.

Results

Eyes without intraocular lens had posterior capsulotomy performed on average 19.7 months after cataract surgery, compared with 27 months for eyes with posterior chamber intraocular lens implant. This was not a statistically significant result.

Pre-operatively 18 eyes had a visual acuity of $\leqslant 6/12$ and three eyes had an acuity of 6/9. The acuity was improved in 20 eyes, the same in one eye and no eye suffered a deterioration in visual acuity. Eighteen eyes, that is 86 per cent, had a post-operative visual acuity of $\geqslant 6/9$.

With respect to the ability of the white light interferometer to predict a potential post-operative visual acuity, the scatter plot shown in Figure 1, displays the interferometry prediction of post-operative visual acuity plotted against the achieved post-operative acuity (using a decimal scale). The interferometry

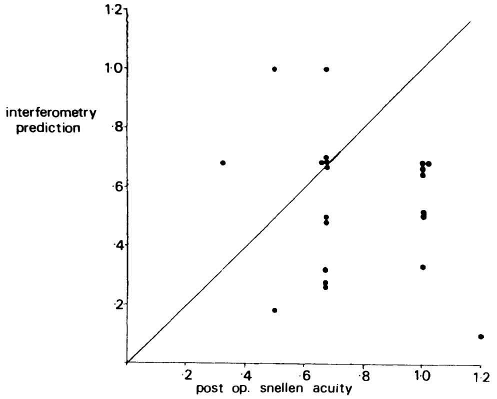

Fig. 1. *Interferometry prediction compared with post-operative Snellen acuity (decimal scale).*

prediction was accurate when compared with the actual post-operative Snellen acuity in 19 per cent of eyes, within one Snellen line in 52 per cent of eyes and within two Snellen lines in 76 per cent of eyes. The coefficient of correlation was 0.50, and the p value was <0.05.

Discussion

In theory interferometers should be able to predict a potential visual acuity in eyes with opacity of the refracting media, e.g. posterior capsule opacification.

In practice however, both with laser and white light interferometers, several types of false negative and false positive results can be obtained.

False negative results, that is falsely pessimistic predictions of visual acuity may be obtained when the beam is not penetrating the opacity nor entering the pupil, when there is poor cooperation by the patient and when there is poor technique by the operator.[13]

False positive results, that is falsely optomistic predictions of visual acuity, may be obtained in amblyopia, cystoid macular oedema, serous detachment of the sensory epithelium, macular holes, geographical atrophy of the pigment epithelium, early post-operative retinal detachment and visual field cut through fixation.[13,14]

As can be seen in Figure 1, in our hands, the white light interferometer tended to underestimate the potential visual acuity, i.e. produce false negative results despite the fact that the eyes were ophthalmoscopically normal, pupils were dilated and careful technique was used. The ability of the patient to discern the interference fringe pattern depends not only on the spatial frequency of the grating, but also on its contrast. The fringe contrast may be decreased by stray light;[11] in this study we found it necessary to use low background illumination in order to ensure that the interference grating was entering the eye, and this stray light may have reduced the grating contrast and hence contributed to the high false negative rate. Alternatively the fringe pattern may not be penetrating the opacity adequately.

Faulkner[15] used the Visiometer white light interferometer to predict post-operative visual acuity in patients presenting for posterior capsulotomy and found the prediction of visual acuity to be within one Snellen line in 29 out of 30 patients (97 per cent). Spurny *et al.*,[16] on the other hand, found the same type of instrument to be accurate to within one Snellen line in nine out of 15 patients (60 per cent). This latter figure compares with our own of 52 per cent, for the Site white light interferometer.

Considering the clinical situation, could the white light interferometer aid the clinician in deciding whether or not to perform posterior capsulotomy? In this situation the clinician might well ask 'Is this patient likely to achieve a good post-operative visual acuity?' Taking 6/12 as the cut off point, Table I shows the accuracy of the white light interferometer in predicting a visual acuity of $\geqslant$6/12 or $\leqslant$6/18 post-operatively.

Fourteen of the 15 eyes predicted to achieve a post-operative Snellen visual acuity of $\geqslant$6/12 did in fact do so; however all eyes predicted to achieve a visual acuity of $\leqslant$6/18 obtained a better post-operative visual acuity than this.

Table I *Accuracy of prediction in the clinical setting*

	No. of eyes
Prediction of $\geqslant$6/12 post-operatively	
Accurate	14
Inaccurate	1
Prediction of $\leqslant$6/18 post-operatively	
Accurate	0
Inaccurate	6

In the clinical situation one might therefore say that if the interferometry prediction of potential visual acuity is ≥6/12 there is a high probability (93 per cent in this study) that the actual post-operative visual acuity will be within this range. However a high degree of caution would have to be exercised if the clinician was relying on an interferometry prediction of a poor visual acuity post-operative (≤6/18), since in this study all such eyes achieved a better visual acuity than this. In this situation a patient who would benefit from posterior capsulotomy might not have it performed if the clinician was relying on the interferometry prediction alone.

We therefore conclude that as with all instruments the white light interferometer should not be used in isolation but in conjunction with careful clinical assessment.

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