outh East Asia Glaucoma Interest Group

Volume 8 Number 3 June 2006

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As new technologies and therapeutic interventions are continually being developed, ophthalmology has become a field of rapid change, particularly in the Asia-Pacific region, where disease patterns and health care delivery differ greatly from those seen in the West. *Asian Journal of OPHTHALMOLOGY* was established in 1998 and became the official journal of SEAGIG in 2003, with the aim of disseminating information relevant to ophthalmology and glaucoma throughout Asia and to interested groups worldwide. The objectives of *Asian Journal of OPHTHALMOLOGY* are as follows:

- to provide a platform for the publication of information with a focus on ophthalmology in Asia
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- to increase the understanding of such disorders through reporting of educational activities
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Volume 8 Number 3 June 2006

Table of Contents

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Imaging Technology for Glaucoma

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The introduction of several new imaging technologies for assessing the retinal nerve fibre layer (RNFL) and optic disc in the past decade is rapidly changing our current management of glaucoma. As a substantial number of retinal ganglion cells (RGCs) can be lost before visual field defects become manifest on standard white-on-white perimetry, there is great interest in these technologies in the hope that they may be able to accurately reflect changes in the number of RGCs. Indeed, as structural changes in the RNFL and in the optic nerve head precede functional changes in glaucoma, the assessment of these structures has now assumed prime importance in the diagnosis of glaucoma as well as in the detection of its progression. Various technologies, including confocal scanning laser ophthalmoscopy, scanning laser polarimetry, and optical coherence tomography, have been developed to allow objective assessment of structural changes. Easy image acquisition combined with high reproducibility of measurements may improve our ability to detect progression earlier. However, the role of these newer technologies in the day-to-day management of glaucoma worldwide has not been firmly established as a standard. With different training experiences and disparate budgetary constraints, the type of devices used by clinicians varies. Furthermore, clinicians are often faced with difficulties as instrument manufacturers strive to improve their devices and discontinue or stop supporting older models. The availability of large normative databases as well as analysis programmes also varies widely between the different devices.

In addition, the wide biological variability in the normal ocular structures implies that there will be patient subgroups whose images have to be interpreted using modified algorithms. As more research is done, more algorithms will be developed to help us fine-tune our interpretation of such patient subgroups. The article by Arvind et al in this issue of *Asian Journal of OPHTHALMOLOGY* illustrates this point well.[1] These authors suggest that scanning laser polarimetry (SLP) measurements increase following cataract extraction with intraocular lens implantation, ie cataracts give a false impression of a thinner RNFL. Hence, cataract progression in a patient with stable glaucoma may result in worsening SLP values that can be misinterpreted as worsening of the glaucoma. These authors also found that the changes in SLP values were similar whether the cataract extraction was achieved by extracapsular or manual small incision techniques. These values were similar to those reported in other studies after phacoemulsification.[2] This finding would suggest that we should perform new baseline measurements in all patients following cataract extraction. It is unfortunate that the authors used a GDx with fixed corneal compensation in their study as this device is now largely obsolete and most clinicians are using the variable corneal compensation (VCC) device instead. A recent paper by Vetrugno et al found no changes in RNFL thickness before and after phacoemulsification using the VCC device, suggesting that the VCC device accurately measures any changes in corneal compensation induced by cataract surgery, assuming no changes occurred in the RNFL pre- and post-surgery.[3]

As more information is obtained through research and our understanding of the various imaging devices increases, their integration into clinical practice will continue to refine and shape our management of glaucoma. While some devices may become obsolete, let us hope that we can retain and develop those that are of value. *Asian J Ophthalmol. 2006;8:85*

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Effect of Extracapsular and Manual Small Incision Cataract Surgery with Intraocular Lens on Scanning Laser Polarimetry

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Purpose: *To study the effect of cataract surgery with intraocular lens implantation on scanning laser polarimetry.*
Methods: *This was a prospective, cohort study. Scanning laser polarimetry using the GDx nerve fibre analyser was performed on 53 eyes of 53 patients who subsequently underwent cataract extraction and intraocular lens implantation by extracapsular extraction or manual small incision cataract surgery, and repeated at the final postoperative visit. Preoperative and postoperative values were compared using the paired t test. The patients were divided into 2 subgroups based on the type of surgery, and the mean differences between pre- and postoperative values for each parameter were compared between the subgroups using independent samples t test.*
Results: *There was a significant increase in scanning laser polarimetry values for superior and inferior maxima ($p < 0.001$ for both), superior and inferior ratios ($p < 0.001$ for both), superior/nasal ratio ($p < 0.001$), superior and inferior averages ($p < 0.001$ for both), ellipse average ($p < 0.001$), ellipse modulation ($p = 0.001$), maximum modulation ($p < 0.001$), and average thickness ($p = 0.002$) postoperatively compared with preoperative values. The number showed a significant decrease ($p < 0.001$). When eyes were classified into subgroups based on the type of surgery, there was no significant difference in the amount of change postoperatively for any of the parameters between the subgroups.*
Conclusions: *Scanning laser polarimetry parameters changed significantly following extracapsular or manual small incision cataract surgery with intraocular lens implantation. This change was not affected by the type of cataract surgery.*

Key words: *Cataract, Nerve fibers, Scanning laser polarimetry*

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Introduction

GDx is a scanning laser polarimeter that measures the thickness of the peripapillary retinal nerve fibre layer (RNFL). GDx utilises a polarised 780 nm diode laser beam, which is focused on the retina and is reflected by the deeper retinal structures. As the beam double passes the RNFL, it undergoes a change in the state of polarisation, a phenomenon known as retardation. The degree of retardation is proportional to the thickness of the NFL through which the beam passes and is used to estimate the thickness of the NFL.[1] Scanning laser polarimetry (SLP) has been shown to be useful for distinguishing healthy eyes from glaucomatous eyes,[2] and to have good sensitivity and specificity for diagnosing glaucoma.[3]

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Other ocular structures that may contribute to retardation are the cornea[4] and the crystalline lens.[5] The GDx version 1.0.16 (Laser Diagnostic Technologies, San Diego, USA) assumes a fixed slow axis of the corneal polarisation as 15° nasally downwards.[6] Inter-individual variations in corneal polarisation have been shown to exist.[6] A later version of the GDx incorporates a custom corneal compensator. However, corneal polarisation has been shown to be fairly constant in individual patients over time[7] and therefore would not affect longitudinal follow-up of individual patients.

Previous studies of the effect of cataract surgery with intraocular lens (IOL) implantation on SLP parameters have revealed higher SLP parameters after surgery, with some differences between individual reports.[8-11] However, all the studies performed to date have only investigated the effects of cataract removal by phaco-emulsification. In India, where the majority of patients do not have medical insurance schemes, many patients prefer the cheaper

alternative of extracapsular cataract extraction (ECCE) or manual small incision cataract surgery (SICS) to phacoemulsification, which costs more. The effects of ECCE and manual SICS on the anterior segment birefringence may be different from that of phacoemulsification. ECCE and manual SICS require larger incisions, with more anterior incisions required for ECCE. The aim of this study was to examine the effects of ECCE and manual SICS with IOL implantation on SLP parameters.

Methods

This was a prospective, cohort study. The study was approved by the institutional review board and written informed consent was obtained from all participants.

Patients

Fifty three patients with visually significant cataract who satisfied all the inclusion criteria and were willing to enrol in the study were recruited from the outpatient clinic at the Medical and Vision Research Foundation, Sankara Nethralaya, Chennai, India, between June 2001 and November 2002.

Preoperative Evaluation

Preoperative evaluation included recording of best-corrected visual acuity (BCVA), slit-lamp examination, SLP (GDx, version 1.0.16; Laser Diagnostic Technologies, San Diego, USA), intraocular pressure (IOP) recording with applanation tonometry, gonioscopy, dilated fundus evaluation, grading of cataract according to the Lens Opacities Classification System II (LOCS II),[12] and optic disc stereo photography. The inclusion criteria were as follows:

- age 40 years or older
- IOP <22 mm Hg
- normal ocular examination except for the presence of cataract
- visual disability attributable to cataract
- willing to undergo cataract surgery.

SLP was performed by 1 of 2 experienced optometrists under normal ambient illumination with undilated pupils. One high-quality image of the optic disc and the peripapillary NFL was taken for each eye. Image capture was repeated up to a maximum of 3 times until a high-quality image that was well centred and focused, with equal illumination and adequate coverage in all quadrants, was obtained. The ellipse was placed around the optic disc and the symmetry analysis printout was obtained.

Cataract was considered significant if it was LOCS II grade ≥NII (nuclear opalescence of ≥grade II), and/or ≥PII (posterior subcapsular opacity of grade ≥II). However, surgery was advised only if the patient had significant visual disability attributable to the cataract. The eligible patients subsequently underwent cataract surgery with IOL implantation by 1 of 2 techniques, namely ECCE or manual SICS, by a modification of Blumenthal's method,[13] with all patients receiving a single-piece polymethyl methacrylate (PMMA) IOL (John Fowler Ophthalmics Ltd, Mumbai, India). The choice of the technique of cataract surgery was left to the surgeon.

Surgical Techniques

For ECCE, after administration of peribulbar anaesthesia, a 10- to 12-mm triplanar limbal incision was made straddling 12 o'clock. Can-opener capsulotomy was performed after viscoelastic injection. The section was then extended, and the nucleus was delivered by applying pressure at the 6 o'clock limbus and counterpressure just above the 12 o'clock limbus. Cortical clean up was done using a manual irrigation-aspiration cannula. The IOL was inserted under viscoelastic cover after cortical removal and dialled into position. The viscoelastic was then removed using the manual irrigation-aspiration cannula, and the wound was closed with 5 to 7 interrupted radial sutures.

For manual SICS,[13] a 5.5-mm partial thickness scleral incision with 1.5- to 2-mm backward extensions was made 2 mm posterior to the superior limbus. A scleral tunnel was dissected starting from this incision, and dissected toward the clear cornea so that the inner lip of the wound extended from the 10 o'clock to the 2 o'clock positions. An anterior chamber maintainer was introduced through an oblique corneal incision at 6 o'clock. A cystitome was introduced through a separate stab incision, followed by anterior capsulotomy and hydrodissection. The nucleus was manipulated into the anterior chamber and delivered by a combination of the stream of irrigation fluid from the anterior chamber maintainer, with the surgeon holding the lips of the wound open and manipulating the nucleus if required. Cortical clean-up was followed by IOL insertion under viscoelastic cover. Viscoelastic was then removed, and the wound tested for integrity.

Postoperative Evaluation

Postoperative SLP evaluation was done at least 6 weeks after surgery. In addition to SLP, all the procedures performed at baseline evaluation were repeated. Any patient with ≥3.5 D astigmatism was followed-up for review after 1 month for repeat refraction and keratometry. Suture removal was performed if necessary. SLP was performed when astigmatism was ≤3.5 D. Patients who reported for postoperative evaluation more than 6 months after the baseline examination were excluded.

Only those patients for whom high-quality GDx images were obtained before and after surgery were considered for analysis. In order that the analysis be clinically applicable, only those parameters that appear on the symmetry analysis printout were analysed.

Exclusion Criteria

Patients with poor-quality images, either pre- or postoperatively, corneal disease, media haze due to any cause other than cataract, IOP >21 mm Hg, glaucoma or glaucoma suspect, significant retinal pathology, optic nerve pathology, tilted discs, large areas of peripapillary atrophy, or an interval between pre- and postoperative SLP of more than 6 months were excluded.

Statistical Analysis

The differences between preoperative and postoperative GDx parameters were analysed for the whole group using paired *t* test. A p value of <0.0036 was considered significant after applying Bonferroni's correction for multiple comparisons. The mean differences between the ECCE and SICS groups for each of the parameters were compared using independent samples *t* test. When both eyes of the same patient satisfied the inclusion criteria, the right eye alone was included for analysis.

Results

Fifty three eyes of 53 patients satisfied all the inclusion criteria and were included for analysis; this was exclusive of 5 patients who had good images preoperatively, but poor images postoperatively. The mean age of the patients was 60.40 years (SD, 9.33 years). There were 24 men and 29 women. Thirty two eyes were right eyes and 21 were left eyes. The duration between pre- and postoperative SLP ranged from 44 to 174 days (mean, 86.81 ± 34.21 days). Seventeen eyes had a combination of nuclear, cortical, and posterior subcapsular cataract (PSC), 15 eyes had nuclear sclerosis and PSC, 6 eyes had nuclear and cortical cataract, 14 had only nuclear sclerosis, and 1 had PSC.

25 eyes underwent ECCE with IOL implantation and 28 eyes underwent manual SICS with IOL implantation. All the operations were uneventful. The postoperative spherical equivalent ranged from -2.75 to +0.88 (mean, -0.58 to +0.78). All patients had astigmatism ≤2.5 D at the time of the final postoperative evaluation. Table 1 shows the pre- and postoperative values for each of the 14 parameters. There was a significantly lower value noted postoperatively for the number, with higher superior maximum, inferior maximum, average thickness, superior average, inferior average, ellipse average, superior/nasal ratio, superior ratio, inferior ratio, maximum modulation, and ellipse modulation. The difference between postoperative and preoperative values for each of the 14 parameters, as well as spherical equivalent, were calculated separately for the 2 surgical groups and compared with each other (Table 2). There were no significant differences between the 2 surgical groups for any of the values.

Discussion

SLP has been shown to be an effective tool for screening for glaucoma. Since both cataract and glaucoma are diseases of ageing, the prevalence of both conditions increases with age. Patients undergoing longitudinal follow-up with the GDx are likely to require cataract surgery at some point. It is therefore important to know how the different cataract techniques influence GDx measures.

Several authors have examined the effect of cataract surgery by phacoemulsification and IOL implant on GDx parameters.[8-11] Park et al have reported a significant increase in NFL thickness after phacoemulsification with IOL, especially in eyes that received acrylic lenses.[8] Chiba et al also found positive correlations with cataract density and concluded that SLP may underestimate NFL thickness in individuals with dense cataract.[9] In an elaborate study of 138 eyes including in vivo and in vitro evaluation of different IOL types, Kremmer et al found higher NFL thickness values after cataract

Table 1. Comparison of preoperative and postoperative GDx parameters (n = 53).

Parameter	Preoperative Mean (SD)	Postoperative Mean (SD)	Postoperative-preoperative Mean	Percent change*	p Value
Superior maximum	82.380 (16.100)	88.420 (16.600)	6.040	7.33	<0.001
Inferior maximum	79.400 (16.640)	86.660 (16.700)	7.260	9.14	<0.001
Average thickness	59.250 (10.170)	61.700 (10.960)	2.450	4.14	0.002
Superior average	68.530 (12.760)	72.720 (12.100)	4.190	6.11	<0.001
Inferior average	72.080 (13.550)	77.910 (14.710)	5.830	8.09	<0.001
Ellipse average	62.720 (11.020)	66.340 (11.280)	3.620	5.77	<0.001
Superior integral	0.192 (0.040)	0.197 (0.040)	0.005	2.71	0.042
Superior/nasal	1.950 (0.330)	2.120 (0.340)	0.170	8.72	<0.001
Superior ratio	2.000 (0.390)	2.230 (0.420)	0.230	11.50	<0.001
Inferior ratio	1.940 (0.350)	2.180 (0.420)	0.250	12.89	<0.001
Symmetry	1.033 (0.100)	1.028 (0.130)	0.005	0.48	0.702
Maximum modulation	1.140 (0.330)	1.380 (0.420)	0.240	21.05	<0.001
Ellipse modulation	2.050 (0.560)	2.370 (0.680)	0.320	15.61	0.001
Number	30.600 (20.930)	19.420 (16.750)	-11.180	36.54	<0.001

* Refers to percentage change from preoperative value.

Table 2. Extracapsular cataract surgery (ECCE) versus manual small incision cataract surgery (SICS).

Parameter	ECCE (postoperative-preoperative) [n = 25] Mean (SD)	SICS (postoperative-preoperative) [n = 28] Mean (SD)	p Value
Superior maximum	5.920 (10.400)	6.140 (7.290)	0.92
Inferior maximum	8.680 (10.640)	6.000 (7.400)	0.28
Average thickness	2.800 (5.740)	2.140 (5.060)	0.66
Superior average	5.120 (6.880)	3.360 (5.520)	0.30
Inferior average	5.760 (8.650)	5.890 (7.970)	0.95
Ellipse average	4.440 (6.420)	2.890 (5.180)	0.33
Superior integral	0.006 (0.020)	0.004 (0.018)	0.73
Superior/nasal	0.130 (0.190)	0.190 (0.250)	0.32
Superior ratio	0.250 (0.430)	0.220 (0.310)	0.80
Inferior ratio	0.280 (0.430)	0.220 (0.300)	0.57
Symmetry	-0.012 (0.096)	0.002 (0.083)	0.57
Maximum modulation	0.230 (0.350)	0.250 (0.300)	0.83
Ellipse modulation	0.340 (0.600)	0.310 (0.700)	0.89
Number	-11.760 (18.880)	-10.680 (14.160)	0.81
Spherical equivalent	-0.725 (0.789)	-0.459 (0.767)	0.22

surgery for all IOL types, but this was statistically significant only for PMMA lenses.[10] These authors found that, in vitro, none of the IOLs had significant birefringence effects. Gazzard et al studied 49 patients with glaucoma before and after phacoemulsification with acrylic IOLs and found a significant increase in measures after surgery.[11] Another in vitro study of the birefringence properties of IOLs found that, except for compression-molded PMMA lenses, none of the other IOL designs — including lathe-cut PMMA (which was the design used in our study), acrylic, and silicone lenses — had significant birefringence properties.[14] The logical conclusion from these studies would be that the opacified crystalline lens has an effect on the SLP measurements, which is removed by its extraction by phacoemulsification. If this were true, and a cataractous lens gives an impression of a thinner NFL on GDx, cataract progression after glaucoma surgery may give an erroneous impression of worsening of GDx despite good IOP control. Differences in cataract surgery may alter the amount of anterior segment birefringence.

Effects on corneal curvature differ between the 3 types of cataract surgery due to the different sizes and placement of sections.[15,16] Other possible sources of variation are the placement of the IOL in ECCE, where decentration is common in view of the can-opener or envelope capsulotomy,[17] and a greater amount of remnant cortical fibres in ECCE and SICS compared with phacoemulsification despite good surgical technique.[15] This study addressed the effect of ECCE and SICS on GDx parameters and found results similar to previous results with phacoemulsification.

The best SLP parameter for the diagnosis of glaucoma has been shown to be the number.[18-21] This study showed a significant decrease in the number following surgery. According to the manufacturer, a number <30 is normal, 31 to 70 implies glaucoma suspect, and >70 implies glaucoma. The preoperative mean number was 30.60 and the postoperative mean number was 19.42. Considering that all the patients had a normal ocular examination except for cataract, the postoperative number appears to better represent the actual NFL status in this group than the preoperative number.

This study showed an increase in all absolute parameters following surgery, with all of them being statistically significant except the superior integral. The ratio-based parameters being ratios of one absolute parameter to another, any change in these parameters would depend on the change in the individual parameters, such as the numerator and/or the denominator. This study resulted in a significant increase in the superior/nasal ratio, superior ratio, and inferior ratio, implying that the superior and inferior maxima increased more than the nasal and temporal values in the respective ratios. The modulation parameters showed a significant increase, which could be explained on the same basis. There was no significant change in the symmetry, but this was as expected because both the superior and inferior maxima increased to a similar extent (Table 1) following surgery.

The type of surgery, whether ECCE or SICS, had no effect on the amount of postoperative change for any of the parameters. These findings correlate with the current understanding that the changes observed in GDx parameters are due to the removal of the cataractous lens. From the findings of this study, it appears that the differences in the anterior segment expected after ECCE and SICS do not cause birefringence effects qualitatively different from phacoemulsification as previously reported. All the patients in this study had astigmatism less than ±2.5 D at the time of SLP. Possibly, this may have minimised the effect of any corneal changes.

This study is the only study so far to examine the effects of ECCE and manual SICS on SLP parameters. The results would be

relevant to any clinical scenario where ECCE or manual SICS are regularly performed, and specifically so if they are performed for patients being followed-up with the GDx.

This study used only 1 image per eye. However, it was ensured that this image was of high quality — it had to be well focused and centered, with adequate illumination and coverage in all quadrants. Image capture was repeated up to 3 times to obtain a high-quality image. If this was not possible, the patient was excluded from analysis. Colen et al have compared the mean of 3 images obtained by the NFA (GDx) to 1 image obtained as the best of 3 images and found no significant differences between them.[22] Better repeatability has been demonstrated with the NFA II but not with the GDx. A previous study by Kwon et al also used 1 good image per eye.[18] Although the maximum interval between pre- and postoperative SLP in the study reported here was 6 months, all patients had a normal ocular examination pre- and postoperatively. Patients with ocular hypertension, glaucoma, diabetic retinopathy, or any other optic nerve or retinal condition that may progress in 6 months were excluded. Therefore, a change in NFL status that may affect the results over 6 months was not expected. Even if there were a change, an increase in retardation values was observed rather than a decrease, which would be expected with time.

ECCE and manual SICS with IOL implant significantly alter SLP parameters. This change is not affected by the type of surgery. New baseline measurements are recommended following cataract surgery with IOL implantation.

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Trans-scleral Diode Laser Ciliary Cyclophotoablation for Refractory Glaucoma

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Aim: *To assess the success of cyclodiode treatment in lowering intraocular pressure and reducing oral medication for patients with uncontrolled glaucoma and to report any adverse events and changes in Snellen visual acuity.*
Methods: *Forty seven patients undergoing trans-scleral diode laser ciliary cyclophotoablation were retrospectively evaluated for refractory glaucoma. More than 50% of patients had painful blind eyes for which treatment was aimed at increasing comfort and reducing medication use, in particular oral acetazolamide. Paired student's t test was used to compare sample means.*
Results: *There were a total of 67 treatments for the 47 patients. The average preoperative intraocular pressure was 41.3 mm Hg (95% confidence interval, 37.6-45.0). The average intraocular pressure at the final follow-up (>3 months) was 22.4 mm Hg (95% confidence interval, 18.1-26.6; p = <0.001). Mean intraocular pressure 10 days post-cyclodiode treatment was 20.5 mm Hg (95% confidence interval, 17.2-23.8) and at 1 month was 26.2 mm Hg (95% confidence interval, 22.6-29.9). Mean power settings were 35 x 1802 mw x 1797 ms. Twenty two patients were taking oral acetazolamide pretreatment compared with only 2 post-treatment. Neovascular glaucoma was the most frequent diagnosis; the mean intraocular pressure was significantly reduced from 58.0 to 26.8 mm Hg (p < 0.001). Two patients experienced reduction in visual acuity of up to 4 Snellen lines, mainly due to the presence of cataract.*
Conclusion: *Trans-scleral diode laser ciliary cyclophotoablation for refractory glaucoma is an effective procedure not only for reducing intraocular pressure but also for reducing the level of medical treatment required for control of intraocular pressure. In particular, there was a 91% reduction in the use of acetazolamide. The procedure is generally safe.*

Key words: *Ciliary body, Glaucoma, Intraocular pressure, Lasers*

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Introduction

The diode laser is a clinically useful source of laser photocoagulation and is being used increasingly to treat refractory glaucoma, with advantages such as portability and adaptability in terms of mode of delivery.[1-7] The treatment is quick and relatively simple to apply and, as a result, has been shown to play an important role in the treatment of glaucoma in developing countries.[8] Trans-scleral delivery takes advantage of the relatively high transmission of the sclera and absorption of the pigment in the ciliary processes at a laser diode wave length of 810 nm. The aims of this study were to assess the success of cyclodiode treatment for lowering intraocular pressure (IOP) and reducing the use of oral medication, and to evaluate any adverse events and changes in Snellen visual acuity (VA).

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Methods

Patients

All patients treated between January 1998 to February 2002 at the Leeds General Infirmary, Leeds, UK, were entered into the study. All patients had medically uncontrolled glaucoma despite previous surgery and maximal tolerable and acceptable medical treatment. More than 50% of the patients had painful blind eyes for which treatment was aimed at maximising comfort and reducing medication use, in particular oral acetazolamide. Follow-up was done after 10 days and 1 month, with a minimum follow-up period of 3 months. All IOP measurements were made using Goldman applanation tonometry in mm Hg. Informed consent was obtained from all patients.

Procedure

Trans-scleral diode laser ciliary cyclophotoablation (TSCP) was performed using the IRIS G-probe (810 nm; IRIS Medical Instruments, Mountain View, USA), which can only be used with certain models of the Iris Oculight® Diode Laser System (IRIS Medical Instruments, Mountain View, USA). Transillumination was used in all eyes to identify any anomalies in the anatomy of the ciliary body before applying treatment. Depending on the level of treatment required, 20 to 40 applications were performed 1.5 mm from the limbus, using lidocaine 2% 3 mL sub-tenons anaesthesia. 270° laser was performed for patients who had undergone previous drainage surgery. Power varied from 1500 mw to 2000 mw and time varied from 1500 ms to 2000 ms, depending on the estimated level of treatment required. The estimated level of treatment was based on the pretreatment IOP, diagnosis, response to previous treatment, level of pigmentation, and visual potential of each patient.

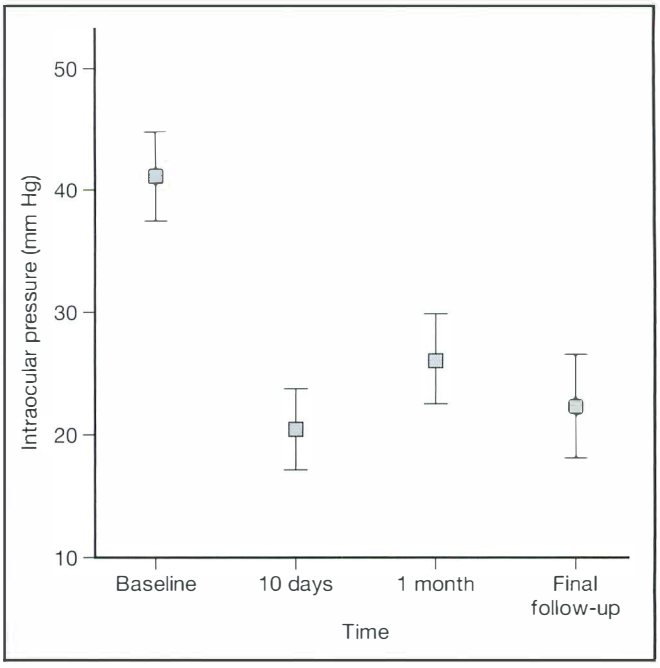
The dose was altered according to the presence or absence of audible 'pops' during the treatment session. An energy of 2000 mw for 2000 ms resulted in a power of 4.0 J/pulse. Postoperative treatment consisted of g ketorolac trometamol 0.5% 4 times daily, g atropine 1% twice daily, and g prednisolone acetate 1% 4 times daily. Repeat diode cyclophotocoagulation was performed in some patients whose IOP did not respond adequately after the first postoperative month. Retreatment was performed using the same technique as the initial treatment. Statistical analysis was performed using the Statistical Package for the Social Sciences version 11.5 for Windows 98. Paired student's *t* test was used to compare sample means.

Results

Forty seven of 59 case notes were available for analysis. Forty nine eyes had treatment; 2 patients had both eyes treated. The average age was 60.1 years (SD, 18.9 years; median, 63 years; range, 15 to 87 years). Sixty four percent of patients were men. Sixty eight percent had the left eye treated. Thirty three eyes required a single treatment, 15 patients had 2 treatments to the same eye and 1 patient with post-traumatic glaucoma underwent 4 treatments. There were a total of 67 treatments for the 47 patients. The results are shown in Figure 1.

The average preoperative IOP was 41.3 mm Hg (95% confidence interval [CI], 37.6-45.0). The average IOP for eyes following all treatments and at final follow-up (>3 months) was 22.4 mm Hg (95%CI, 18.1-26.6). There was a significant lowering of IOP following treatment (t = 7.67; $p < 0.001$). The average IOP 10 days post-cyclodiode therapy was 20.5 mm Hg (95%CI, 17.2-23.8) and at 1 month it was 26.2 mm Hg (95%CI, 22.6-29.9), showing statistically significant reductions (t = 10.83, 6.98; $p < 0.001$). Settings for the cyclodiode laser averaged 35 x 1802 mw x 1797 ms.

Figure 1. Intraocular pressure (mean and 95% confidence intervals) before and after treatment with trans-scleral diode laser ciliary cyclophotoablaton for patients with refractory glaucoma.



Twenty two patients were taking oral acetazolamide pretreatment compared with 2 post-treatment; 1 of the 2 patients declined further cyclodiode treatment having not shown an improvement in IOP after 2 treatments.

Table 1 shows the primary diagnosis of the patients. Neovascular glaucoma was the most frequent diagnosis. The mean IOP was significantly reduced in patients with this diagnosis from 58.0 to 26.8 mm Hg (t = 6.67; $p < 0.001$). Mean IOP reduction for patients with aphakic glaucoma was from 43.5 to 18.1 mm Hg at maximum follow-up (t = 4.35; $p = 0.003$).

Table 1. Primary diagnosis of patients receiving trans-scleral diode laser ciliary cyclophotoablation.

Glaucoma type	Number of patients*
Neovascular	14
Sturge-Weber syndrome	2
Primary open angle	3
Uveitic	4
Aphakic	8
Chronic narrow angle	2
Traumatic	4
Pseudoexfoliation syndrome	1
Trabecular dysgenesis	5
Pseudophakic	3
Retinopathy of prematurity	1

* Two patients who underwent bilateral treatment had choroiditis with secondary rubeosis and juvenile idiopathic arthritis with secondary aphakic glaucoma.

Table 2. Change in visual acuity from baseline.

Lines lost (-) or gained (+)	Number of eyes
-4	1
-3	1
-2	0
-1	7
0	35
+1	4
+2	1

Iridocorneal endothelial syndrome and combined aniridia with aphakia accounted for 2 cases of trabecular dysgenesis. Fuch's heterochromic iridocyclitis accounted for 2 cases of uveitic glaucoma.

Adverse Events and Visual Acuity

The patient with retinopathy of prematurity rubeotic glaucoma had a total retinal detachment 6 weeks after treatment and underwent evisceration. Visual acuity was perception of light preoperatively. One patient did not show an improvement in IOP after 2 treatments and declined further treatment. Another patient, who had had a corneal graft for pseudophakic bullous keratopathy, developed graft rejection 4 months post-cyclodiode therapy. A patient due to undergo 2 treatments had the first session abandoned due to inadequate local anaesthesia. Following the first procedure, a patient with pseudophakic glaucoma had an IOP of 2 mm Hg and required drainage of choroidal effusions. The change in Snellen VA is shown in Table 2.

The VA of 4 patients was 6/9 or better before treatment. For 1 of these patients, the VA deteriorated from 6/6 to 6/9 following treatment. Twenty eight patients had an initial VA of counting fingers or worse. The patient who lost 3 lines of acuity was a 75-year-old man with uveitic glaucoma who had 2 treatments. His initial visual acuity was 6/18 and deteriorated to counting fingers due to the presence of cataract. The patient who lost 4 lines of VA was an 86-year-old woman with neovascular glaucoma and mild nuclear sclerosis. Her vision deteriorated from 6/18 to counting fingers 10 days after treatment. This was due to moderate postoperative uveitis with cataract. One patient underwent 4 treatments to the same eye and lost no lines of VA.

Discussion

Cyclodiode laser treatment for uncontrolled glaucoma is an effective procedure not only for reducing IOP but also for reducing the level of medical treatment required for control of IOP. This study resulted in a 91% reduction in the use of acetazolamide, which is comparable to other studies.[3] The procedure is generally safe although 2 patients in this study experienced objective reduction in VA of up to 4 Snellen lines mainly due to the presence of cataract or postoperative uveitis.

Neovascular glaucoma was the most frequent diagnosis. The mean IOP was significantly reduced for patients with this diagnosis from 58.0 to 26.8 mm Hg ($t = 6.67$; $p < 0.001$). TSCP has previously been suggested to be less effective for treating glaucomas associated with obstruction in aqueous outflow, particularly neovascular glaucoma.[9] This study shows a more favourable result, with a 54% reduction in IOP for 14 patients with neovascular glaucoma. Two patients had narrow angle glaucoma. IOP was reduced in 1 patient from 22 to 15 mm Hg at final follow-up, while the other patient did not show any improvement in IOP (23 to 24 mm Hg) and required acetazolamide 10 months post-treatment. Patients with aphakic glaucoma showed a 58% reduction in IOP. One of the patients with aphakic glaucoma had a preoperative IOP of 72 mm Hg. Ten days post-treatment (40 x 1750 mW x 1500 ms) the IOP was 1 mm Hg. At final follow-up, the IOP was 13 mm Hg.

Coagulation or destruction of the ciliary body to reduce the rate of aqueous production has been advocated in the treatment of glaucoma since the 1930s.[10] Non-contact diode cyclophotocoagulation has been shown to reduce IOP by approximately 38% for up to 1 year.[11] TSCP with the contact diode laser has previously been reported to cause a durable reduction in IOP in approximately two-thirds of eyes with severe, medically uncontrolled glaucoma.[12] Mean IOP reduction has been found to be 44%.[2] This study resulted in a 46% reduction in IOP from baseline at final follow-up (>3 months). Reported complications of the procedure included malignant glaucoma,[13] lens subluxation,[14] atonic pupil,[8] and phthisis bulbi in 2 of 68 patients prospectively studied by Brancato et al.[15] Corneal graft failure rates have been found to be 9.5%.[1] Phthisis occurred in 1 patient in this study who underwent evisceration due to total retinal detachment 6 weeks after treatment. Pre-existing risk factors have been identified and phthisis has previously been shown to occur in severely damaged eyes that are difficult to treat.[16]

Reproducibility of Snellen VA assessment is poor, in particular at low VA levels.[1] This may explain why some eyes in this study appeared to have a better VA at last follow-up than before treatment. Another reason may be a reduction in corneal oedema in eyes with a very high pretreatment IOP. One case of graft rejection and a retinal detachment in a high-risk patient occurred in this study although none of these occurred immediately after surgery.

Histologically, cyclodiode produces a characteristic injury with focal damage and minimal inflammation. Pars plicata is usually severely affected with non-specific destruction of ciliary pigmented and non-pigmented epithelium and capillaries in the ciliary processes.[17] The trend in IOP reduction is shown in Figure 1, which shows recovery of IOP after 1 month. Other data show a rebound rise in average IOP that lasts up to 6 weeks.[1] Kramp et al report

a re-treatment rate of 21.2% for 193 eyes.[16] In this study, 32.7% of eyes required multiple treatments. Aside from patient factors, varying results depend on surgical technique and number of laser applications delivered to discrete treatment sites. More applications than suggested[18] were used in this study, as varying scleral indentation from 0 to 1 mm has been reported to cause scleral transmission to vary by 2.6 times.[19] Contact diode laser has also been found suitable as a primary surgical treatment,[8,16] which is advantageous for the control of IOP in patients with poor compliance. Other studies show cyclodiode laser treatment to effectively eliminate discomfort in painful, blind, glaucomatous eyes.[20]

Overall, these data show a significant reduction in IOP following TSCP. Despite this, a few patients had a higher postoperative IOP. However, TSCP reduces the level of medication use, in particular oral acetazolamide, and produces a much more comfortable eye for patients with refractory glaucoma despite the higher IOP.

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Clinical Results of Accommodative Posterior Chamber Intraocular Lens Implantation in Asian Eyes

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Aim: *To evaluate near visual acuity and accommodative power after implantation of an accommodative posterior chamber intraocular lens.*
Methods: *This prospective study analysed 20 eyes of 17 patients who had undergone cataract surgery and implantation of a 1CU posterior chamber intraocular lens. Patients were followed up 1 week and 1, 3, 6, and 12 months after surgery. The following methods were used to measure accommodation: dynamic (subjective near point) or static with pharmacologic stimulation using 2% pilocarpine eye drops (change in anterior chamber depth).*
Results: *Mean values at 12 months were as follows: near visual acuity with distance correction, 0.59 (SD, 0.17; range 0.30 to 0.80) and accommodative amplitude by subjective near point, 2.04 D (SD, 0.70 D). At 3 months, the mean change in anterior chamber depth following pilocarpine stimulation was a decrease of 0.69 mm (SD, 0.22 mm). Posterior capsule opacification reduced and Nd:YAG capsulotomy restored accommodative amplitude.*
Conclusions: *Accommodation after implantation of an accommodative IOL should be assessed by several techniques, both subjective and objective, to differentiate true pseudophakic accommodation from pseudoaccommodation. In the present study, patients who were implanted with the 1CU intraocular lens showed improved near reading ability and were less dependent on spectacles for this purpose.*

Key words: *Posterior capsule opacification, Pseudoaccommodation, Pseudophakic accommodation*

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Introduction

After cataract surgery and implantation of the standard posterior chamber intraocular lens (IOL) in the capsular bag, there is no accommodation in pseudophakic eyes so patients remain presbyopic. This problem has been partly solved by the introduction of diffractive and bifocal IOLs.[1-3] However, an IOL capable of restoring accommodation represents a better option. A new accommodative IOL has been designed that takes advantage of the continued functionality of the ciliary muscle after removal of the crystalline lens. Independent studies have shown that ciliary muscle contraction takes place in patients of most ages and have therefore demonstrated the potential to restore accommodation using an artificial lens. The 1CU IOL (HumanOptics AG, Erlangan, Germany) is intended to provide pseudophakic accommodation using the anterior movement of the optic (the focus-shift principle) secondary to the contraction of the ciliary muscle. To achieve this, the lens haptics are modified with transmission elements at their fusion with the lens optic.

In phakic eyes, many measurement techniques and devices are available to assess accommodation.[4-6] Some are subjective and are based on the patient's ability to read optotypes on a distant or near target.[6,7] Others measure refraction objectively. If the principle of accommodation in pseudophakic eyes is forward movement of the lens optic resulting from ciliary muscle contraction (focus-shift principle), accommodation amplitude can be determined by measuring the change in the anterior chamber depth (ACD) using ray-tracing techniques or by calculating the refraction with IOL prediction formulae using biometric data obtained from the accommodated and disaccommodated eye. According to Gullstrand's eye model,[8] a forward movement of 1.00 mm effects a refractive change of approximately 1.8 D.[9]

In this prospective non-comparative interventional case series,

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the efficacy, predictability, stability, and safety of the 1CU accommodative IOL were assessed in 20 eyes of 17 patients who underwent cataract surgery with phacoemulsification.

Methods

Patients

The study population comprised 20 eyes from 17 patients with senile and presenile cataract who underwent phacoemulsification and implantation of an 1CU IOL between March and December 2003. Inclusion criteria were preoperative central corneal astigmatism less than 1.0 D, axial length between 22.0 mm and 25.0 mm, preoperative pupil size ≤6 mm (measured in the scotopic condition with Orbscan II [Bausch & Lomb, Salt Lake City, USA]) and endothelial cell density more than 1000/mm^2. Exclusion criteria were age younger than 40 years, prior surgery or laser treatment on the selected eye, previous ocular trauma, mature cataract, pseudoexfoliation syndrome, anterior/posterior synechia, maculopathy, phacodonesis, high myopia, high hypermetropia, amblyopia, macular degeneration, glaucoma, or diabetic retinopathy. The mean age of the patients at the time of surgery was 61 years (range, 42 to 78 years) and the mean preoperative uncorrected visual acuity (UCVA) at distance was 0.28 (range, 0.1 to 0.4) [Table 1].

It was determined that if problems occurred during cataract surgery (radial tear of the capsulorrhexis, diameter of capsulorrhexis greater than 5.5 mm, zonulolysis, rupture of the posterior capsule, vitreous loss), the 1CU IOL would not be implanted. All patients signed an informed consent form approved by Mettapracharak Hospital Research Committee.

Table 1. Patients' characteristics prior to implantation of a 1CU accommodating intraocular lens.

Eye number	Age (years)	Sex	Best-corrected visual acuity	Metric value*
1	48	M	20/200	0.1
2	53	M	20/70	0.3
3	66	F	20/70	0.3
4	65	F	20/200	0.1
5†	53	F	20/100	0.2
6†	53	F	20/100	0.2
7	53	M	20/200	0.1
8	43	M	20/70	0.3
9	78	M	20/70	0.3
10	65	F	20/70	0.2
11	64	F	20/200	0.1
12	63	F	20/200	0.1
13	69	F	20/200	0.1
14	74	F	20/100	0.2
15	73	F	20/70	0.3
16‡	58	F	10/200	0.05
17‡	58	F	10/200	0.05
18§	65	F	20/70	0.3
19§	65	F	20/100	0.2
20	42	M	20/100	0.2
Mean (SD)	60.9 (10.1)			0.28 (0.18)

* Metric value is near visual acuity determined with distance correction.
†,‡,§ Indicates a patient in whom both eyes were treated.

Clinical Examination

All eyes had a complete preoperative ophthalmic examination including slit-lamp microscopy, applanation tonometry, indirect ophthalmoscopy, and specular microscopy. UCVA and best spectacle-corrected visual acuity were assessed using the Nikon Chart Projector (NP-3S; Nikon, Tokyo, Japan). A contact specular microscope (EM-1000; Tomey Technology, Nagoya, Japan) was used for endothelial cell counts. Axial length was measured by the immersion technique and IOL power was calculated according to the Sanders, Retzlaff, Kraff-Theoretical formula (A-constant = 118.1).

Postoperative examinations included slit-lamp evaluation, applanation tonometry, keratometry, manifest refraction, uncorrected and spectacle-corrected near and distance visual acuity, corneal specular microscopy, autorefraction (RK-2; Canon, Tochigiken, Japan), and subjective amplitude of accommodation. ACD was measured with the Orbscan II, a slit-lamp–based system, before and 30 minutes after application of 2 drops of 2% pilocarpine eye drops, administered 5 minutes apart.

Surgical Technique

All operations were performed by 1 surgeon. A 3.0-mm clear corneal temporal incision was created. After continuous curvilinear capsulorrhexis with a diameter of 4 to 5 mm, the nucleus was phacoemulsified, the residual cortex was removed, and the anterior and posterior capsule was vacuum-cleaned (360° by a bimanual technique). The capsular bag was then filled with a viscoelastic solution (Viscoat; Alcon, Belgium). The 1CU IOL was placed in an injector cartridge (Fa Deutschmann, Zittau, Germany) and the IOL was injected into the anterior chamber (Figure 1), and pushed into the capsular bag (Figure 2). Finally, the haptics were unfolded by injecting the viscoelastic solution at the inner junction between each haptic and the optic (Figure 3). The viscoelastic solution was removed from the eye and the corneal wound was closed using a stromal hydration technique. Following surgery, patients were treated with combined antibiotic and corticosteroid eye drops (dexamethasone sodium phosphate 0.03% and tobramycin sulphate 0.3%) 4 times per day for 4 weeks.

Accommodation Assessment and Outcome Measures

Postoperative examinations were performed 1 day, 1 and 4 weeks, and 3, 6, and 12 months after surgery. Patients were refracted for distance. Distance visual acuity was determined with best spectacle

Figure 1. Injection of the 1CU intraocular lens into the anterior chamber.

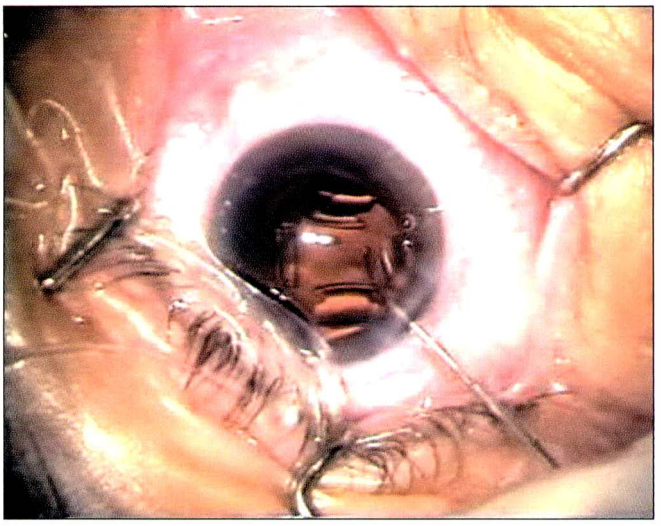


Figure 2. Pushing the intraocular lens into the capsular bag.

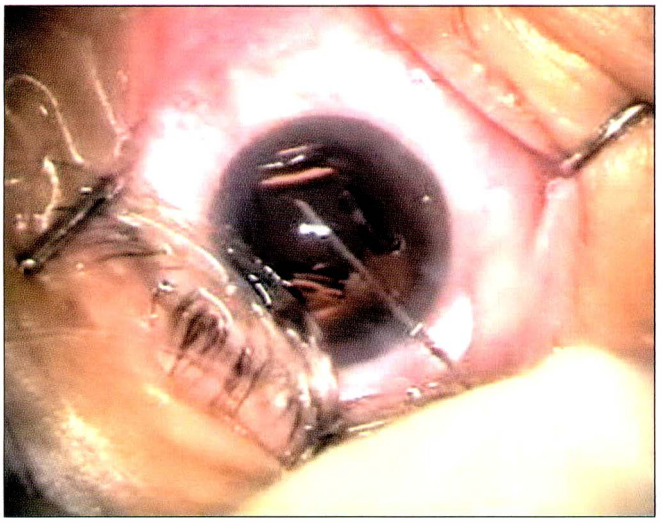
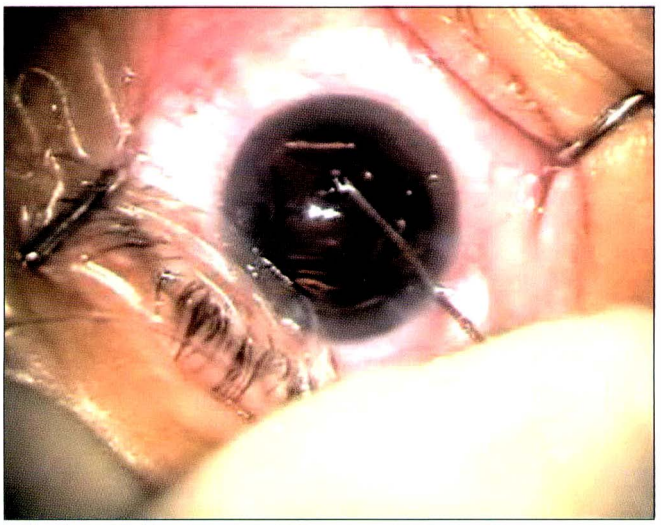


Figure 3. Injecting the viscoelastic solution at the inner junction of the haptic and optic to unfold the haptic.



correction. Subsequently, near reading vision was assessed using the same distance correction and Jaeger charts at 35 cm with an illumination of 600 lux. The reading charts were held by the patients in a normal reading position.

The main outcome measures were subjective refraction, uncorrected distance acuity, best-corrected distance acuity, distance-corrected near acuity at 35 cm, best-corrected near acuity at 35 cm, subjective near point, amplitude of accommodation assessed by subjective push-up test (near point), and change in ACD measured before and after application of pilocarpine 2% eye drops.

Statistical Analysis

All data were collected using specifically designed data sheets and stored in a relational database. Mean values, standard deviations, and ranges were calculated using the Statistical Package for Social Sciences software, version 9.0.

Results

Intraoperative Conditions and Postoperative Outcomes

Surgery was uncomplicated in all patients. The IOLs could be folded within the injection cartridge without damage to the optic or the haptics. After injection into the capsular bag, the IOL optic slowly unfolded whereas the haptics remained folded. By careful manipulation and injection of the viscoelastic solution at the hinge between the haptics and optic of the IOL, it was possible to slowly unfold the haptics inside the peripheral capsular bag without damage to the haptics, lens capsule, or zonules. Thus, successful in-the-bag implantation was achieved in all patients, with the IOL well-centred inside the capsular bag. After complete removal of the viscoelastic solution, the IOL remained in a stable position. The capsulorrhexis remained intact in all patients, and no rupture of the anterior or posterior capsule or vitreous loss occurred.

The postoperative course was uneventful for all patients during follow-up and the IOL remained well-centred inside the capsular bag. None of the patients developed inflammatory fibrin reactions, synechiae, or macrophages on the IOL optic. Five eyes (25%) of 3 patients developed posterior capsular opacification (PCO) in the visual axis within the 12 month follow-up period. Accommodative amplitude decreased in eyes that developed PCO. Nd:YAG capsulotomy was performed on 2 of these eyes and accommodative amplitude improved to the levels observed at 3 months. No signs of shrinkage of the anterior lens capsule or diminution of the size of the capsulorrhexis were observed in any eye. The IOP remained in the normal range (<20 mm Hg) in all patients at all times without antiglaucoma medication.

Table 2. Clinical outcomes 12 months after implantation of a 1CU accommodative intraocular lens.

Eye number	Manifest refraction (D)	Best-corrected distance visual acuity	Near visual acuity with distance correction*	Subjective near point (cm)	Accommodative amplitude†(D)
1	-2.00-1.00 (x 103°)	20/20	0.7 (J2)	60	1.67
2	±0	20/30	0.8 (J1)	35	3.00
3	-0.50	20/30	0.7 (J2)	60	1.67
4	-1.00	20/30	0.8 (J1)	35	3.00
5	+1.50	20/20	0.7 (J2)	45	2.20
6	-0.25-0.25 (x 135°)	20/20	0.7 (J2)	50	2.00
7	+1.25	20/50	0.7 (J2)	60	1.67
8	±0	20/20	0.8 (J1)	35	3.00
9	±0	20/30	0.7 (J2)	60	1.67
10	+0.50-1.00 (x 50°)	20/50	0.5 (J3)	60	1.67
11	-2.75-0.25 (x 180°)	20/30	0.7 (J2)	60	1.67
12	-2.75-0.50 (x 90°)	20/50	0.3 (J7)	65	1.50
13	-1.00	20/20	0.5 (J3)	50	2.00
14	-1.00-0.75 (x 160°)	20/20	0.4 (J5)	100	1.00
15	±0-0.50 (x 113°)	20/20	0.4 (J5)	100	1.00
16	-1.75-1.50 (x 95°)	20/30	0.8 (J1)	35	3.00
17	±0	20/20	0.8 (J1)	35	3.00
18	-0.75	20/20	0.7 (J2)	60	1.67
19	-0.75	20/20	0.7 (J2)	60	1.67
20	-0.50	20/20	0.8 (J1)	35	3.00
Mean (SD)			0.59 (0.17)	53.5 (19.5)	2.04 (0.70)

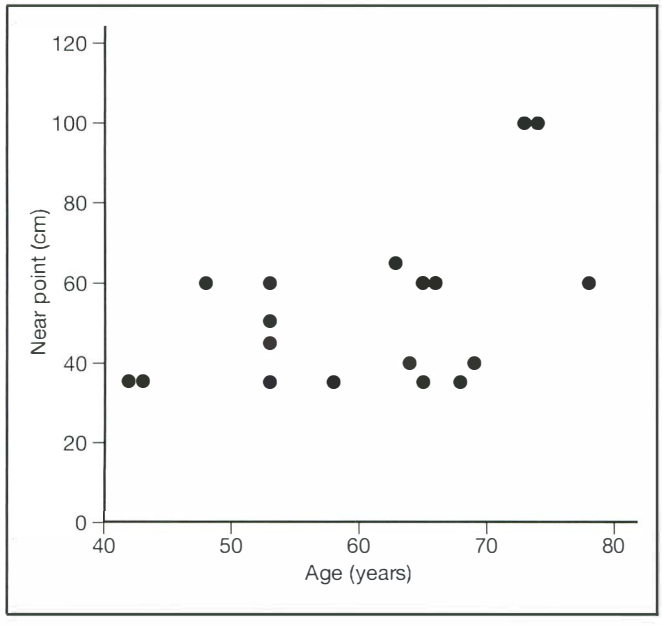
* Metric values are given, with Jaeger chart (J) values in parentheses.
† According to subjective near point.

Visual Acuity and Accommodation

Distance visual acuity with distance correction improved for all patients at 12 months, ranging from 20/50 to 20/20 without pharmacological stimulation (Table 2). The subjective near point determined with best distance correction ranged from 35 to 100 cm (mean, 53.50 cm; SD, 19.54 cm) [Table 2 and Figure 4]. The mean value for near visual acuity with distance correction at 35 cm was 0. 59 (SD, 0.17; range, 0.8 to 0.3; Jaeger number 1 to 7) [Table 2 and Figure 5] and the mean value for accommodative amplitude was 2.04 D (SD, 0.70 D; range, 1.00 to 3.00 D) [Table 2 and Figure 6].

With pharmacological stimulation, the ACD 3 months after IOL implantation ranged from 0.02 to 1.70 mm (mean, 0.44 mm; SD, 0.54 mm) for 15 eyes, as measured by Orbscan II. Based on Gullstrand's model eye, the ACD decrease at 3 months indicated a mean pseudophakic accommodation of 0.79 D. ACD change was not measured 6 and 12 months after surgery.

Figure 4. Subjective near point with best distance correction as a function of patient age.



Discussion

Presbyopia is an unsolved challenge in refractive surgery. Many investigators have analysed the mechanisms of accommodation and presbyopia.[4,10] Langenbucher et al have defined the term 'pseudophakic accommodation' as dynamic change in the refractive state of the pseudophakic eye caused by interactions between the contracting ciliary muscle and the zonules–capsular bag–IOL, resulting in a change in refraction at near fixation.[11] These researchers defined 'pseudophakic pseudoaccommodation' (apparent accommodation) as static optical properties of the pseudophakic eye independent of the ciliary muscle, resulting in improved uncorrected near vision. For example, in patients with corneal multifocality, constricted pupil, and pseudophakic astigmatism, the depth of focus and depth of field increase. Therefore, these patients can read distant and near letters well without a shift of the focus of the IOL. In the dynamic situation (true pseudophakic accommodation), the measurement of

Figure 5. Near visual acuity with best distance correction as a function of patient age.

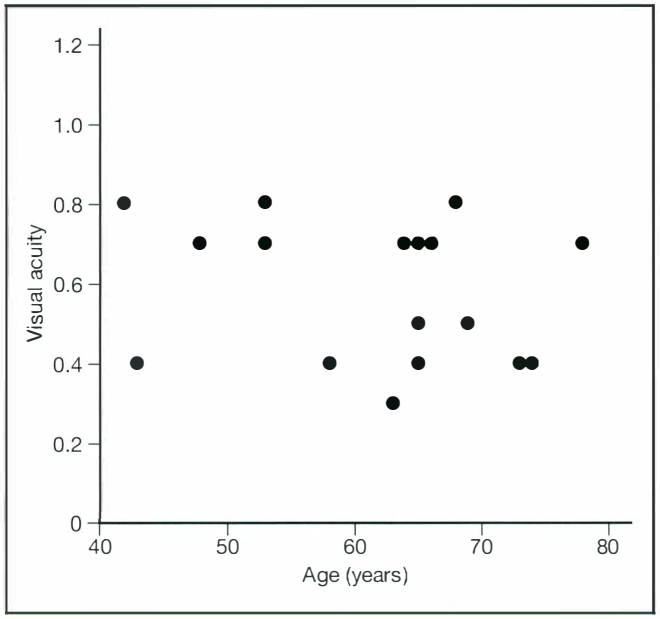
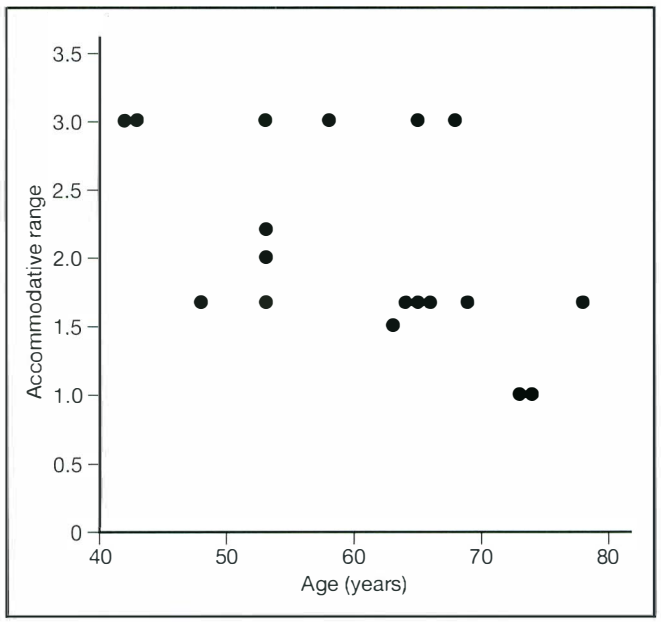


Figure 6. Subjective amplitude of accommodation as a function of patient age.



accommodative amplitude is difficult and lacks repeatability. Accommodation is dependent on the patient's general condition and the external measurement conditions.[6] Small variations in parameters may significantly influence results. The authors of this study have found evaluation of the subjective near point to be the most repeatable and reliable clinical parameter. However, this test measures a combination of true accommodation and pseudoaccommodation.

Several surgical treatment options for presbyopic correction have been proposed, such as scleral expansion surgery,[12] zonal photorefractive keratectomy,[13] implantation of corneal inlays,[14] and diffractive multifocal IOLs.[13] However, these options have achieved no or limited success. Scleral expansion surgery has been shown to be ineffective[15,16] and none of the remaining proposed treatment options for presbyopia allows 'true' accommodation. Other treatments rely on bifocality or multifocality and can lead to glare, halos, and a reduction in contrast sensitivity.

Two accommodative IOLs of different design and materials are currently available, both of which operate by the focal-shift principle. The plate-haptic silicone Crystalens AT-45 IOL (Eyeonics Inc, Aliso Viejo, USA) has a hinged design that allows forward movement of the lens optic as a result of pressure changes in the vitreous cavity when the ciliary muscle contracts. Cumming et al implanted the AT-45 IOL in 76 eyes of 62 patients and found that 92% of the patients had a near acuity of 20/30 or better.[17] The acrylic hydrophilic accommodating 1CU IOL has also been designed to allow transmission of the contracting forces of the ciliary body into anterior movement of the lens optics to achieve pseudophakic accommodation (forward movement of the optic of the IOL). The 4 haptics of the 1CU IOL allow forward movement of the optic in response to true capsular contraction secondary to the ciliary muscle contraction. Because of this, capsular fibrosis markedly affects accommodative amplitude associated with this IOL type, as found in the present study. Mastropasqua et al reported a mean amplitude of accommodation of 1.90 D (SD, 0.77 D) 6 months postoperatively in 14 eyes implanted with the 1CU IOL.[18] These researchers also reported a decrease in accommodation amplitude at 3 and 6 months associated with increased capsule opacity.

The focus-shift principle should result in a defined power of accommodation, theoretically 1.8 D per 1.0 mm of anterior movement of the IOL optic.[19] It has been found that ACD change measured with Orbscan II after pilocarpine application is not a reliable indicator of the physiological condition. It has been noted that this instrument does not really measure the distance between the anterior surface of the lens and the cornea but measures up to the papillary rim only, especially in myopic eyes.[20] Other studies have demonstrated that pilocarpine acts 'physiologically' in young patients with phakia, but is a 'superstimulus' in patients with presbyopic phakia.[21,22] For these reasons, the response of ACD to pharmacological stimulation was not assessed beyond 3 months postoperatively in the present study.

As the accommodative mechanism of the 1CU IOL is based on true capsule constriction secondary to contraction of the ciliary muscle, it relies on elasticity of the lens capsule. Therefore, fibrosis and shrinkage of the anterior and posterior lens capsule has the potential to interfere with the focus-shift action of the 1CU. In the present study, 25% of eyes developed PCO, which was associated

with a decrease in accommodative amplitude at 6 and 12 months postoperatively. A few of the remaining eyes also showed a decrease in accommodative power at 6 to 12 months postoperatively, as reported by Dogru et al,[23] but this was not statistically significant. When Nd:YAG capsulotomy was performed for PCO, accommodative power was restored, as reported by others.[24] There are 2 possible reasons for the high incidence of PCO noted in the present study. First, 1CU IOL does not have a square-edged design and, secondly, the forward movement of the optic means that there is a potential space between the posterior surface of the optic and the posterior capsule into which epithelial cells can migrate. Intraoperative polishing of the anterior and posterior capsule may result in improved postoperative accommodation. In hyperopic eyes, after surgery, the near vision reading was particularly good. In hyperopic eyes, the contractile function of the ciliary muscle appears to be very strong.[25]

The measurement of the axial length of the eye is critical to visual outcome following accommodative IOL implantation. The immersion technique was used in the present study to ensure accuracy. For the 1CU IOL, unlike multifocal IOLs, a refractive result of mild myopia is better than mild hyperopia.

In the present study, the mean amplitude of accommodation was approximately 2 D, similar to that reported in other studies.[18,23,24,26] Accommodative amplitude reached 3 D in 6 eyes. Only 1 eye had a vision level Jaeger number 7 or worse, whereas all other eyes achieved a vision level of Jaeger number 5 or better. The patients whose eyes exhibited accommodative amplitude of 3 D (eyes 2, 4, 8, 16, 17, and 20) tended to be younger than the other patients. Also, near visual activity tended to be better in the 3 patients who had bilateral implantation than in those treated unilaterally. This improved near reading ability cannot be attributed to refractive errors because near acuity was also evaluated in all patients with distance correction. It has been reported that use of the Crystalens AT-45 IOL resulted in near visual acuity of Jaeger number 1 to 3, which remained unchanged at 6 months.[26]

The results of the present study suggest that, in patients who received a 1CU IOL, a better outcome may be achieved when IOLs are implanted in both eyes, in younger patients, or in hyperopic eyes compared with normal eyes. On the other hand, capsular fibrosis (anterior and posterior) has an adverse effect, which can be reversed by Nd:YAG capsulotomy. No change in the accommodative outcome after Nd:YAG capsulotomy for PCO was noted in a study of the AT-45 IOL.[27]

Dogru et al[23] reported an amplitude of accommodation after 1CU IOL implantation lower than that in the present study. However, a different method was used for measuring accommodation in Dogru et al's study. The subjective near-point test used in the present study cannot distinguish between true pseudophakic accommodation and pseudoaccommodation.[11] There is still an urgent need for effective devices that will enable objective and subjective measurement to differentiate between true pseudophakic accommodation and pseudoaccommodation. Dynamic aberrometry,[28] Purkinje image analysis,[29] and the use of a Scheimpflug camera[26] are other methods for measuring amplitude of accommodation.

Although more studies, with a greater number of patients and with longer follow-up are needed to confirm the biocompatibility of and the accommodative amplitude achieved using the ICU IOL, the findings of the present study suggest that pseudophakic accommodation occurs with this IOL. Overall, patients who received the 1CU IOL showed near reading vision equivalent to Jaeger chart 5 or better and were less dependent on spectacles for near reading.

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Vertical Misalignment and its Comparison with Head Tilt in Patients with Peripheral Lateral Rectus Palsy

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Aim: *Isolated unilateral abducens palsy is reportedly associated with a subtle hyperdeviation. The pattern of this often unrecognised associated vertical deviation is described and the affected and unaffected sides compared on head tilt.*

Methods: *In a prospective consecutive case series, 20 patients with isolated unilateral abducens paresis were tested for hyperdeviation. Maddox rod and prism test and prism cover test were done in the 9 diagnostic positions to evaluate hyperdeviation after neutralising the primary esotropia. The tests were repeated during static lateral head tilt to either side. A negative Bielshowsky's head tilt test in all the patients and lack of relative ocular torsion on double Maddox rod test were not compatible with vertical muscle palsy.*

Results: *The mean horizontal deviation was 22.7 pd (SD, 11.9 pd) on prism cover test. Hyperdeviation was present in all patients. The mean hyperdeviation of the affected eye was 5.0 pd (SD, 2.1 pd; range, 3 to 8 pd) in the primary position of the prism cover test. The mean vertical deviation by Maddox rod and prism test was 5.7 pd (SD, 2.7 pd). Head tilt to the affected side revealed a mean deviation of 4.6 pd (SD, 2.4 pd) and head tilt to the unaffected side revealed a mean deviation of 4.8 pd (SD, 1.9 pd) with prism cover test. Head tilt to the affected side revealed a mean vertical deviation of 5.0 pd (SD, 2.6 pd) and head tilt to the unaffected side resulted in mean deviation of 5.1 pd (SD, 2.6 pd) by Maddox rod and prism test. Mann-Whitney test revealed a p value of 0.495 for the alternate prism cover test and 0.909 for the Maddox rod and prism test. No significant difference was found between head tilt to the affected and unaffected side. The side of the abducens paresis did not correspond significantly to the side of the hyperdeviation in the primary position.*

Conclusion: *Small hyperphoria of the affected eye is expected in lateral rectus paresis. The relationship between this hyperdeviation, lateral head tilt, and peripheral and central sixth nerve palsy was not found in this study. The amount of deviation may not depend on the head tilt in peripheral sixth nerve palsy.*

Key words: *Abducens nerve diseases, Esotropia, Exotropia, Oculomotor nerve diseases*

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Introduction

Abducens palsy is the most common ocular motor nerve palsy, characterised by an incomitant esodeviation, with or without a visible limitation of abduction. When a vertical strabismus accompanies defective abduction, a differential diagnosis of multiple cranial nerve palsy, skew deviation (brainstem lesion), myoneural junction disease, or orbital dysfunction may be considered.[1-3] This prospective consecutive non-comparative case series performed at the Aravind Eye Hospital, Madurai, India, prospectively examined patients with isolated abducens palsy for the presence of a hyperdeviation.

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Methods

Patients

Twenty patients with isolated unilateral peripheral abducens palsy were tested for hyperdeviation. A complete history was taken and a detailed ophthalmic and neurological work up was performed. The patients were thoroughly examined in the neuro-ophthalmology department, and any associated systemic disease assessed. The age of onset was noted and associated risk factors such as diabetes mellitus and hypertension were medically controlled if present.

Appropriate tests were performed to rule out any other associated diseases. A presumptive aetiology of ischaemic infarction of the peripheral part of the abducens cranial nerve was provided. Informed consent was given by all the patients.

Orthoptic Assessment

The amount of horizontal and vertical deviation was measured in all 9 diagnostic positions. The range of duction was noted and all patients had normal vertical extraocular range of movement. Bielshowsky's head tilt test was negative for all patients, and there was no evidence of cyclodeviation on the double Maddox rod test. The 9 diagnostic positions were as follows:

- the straight ahead position
- 4 secondary positions of 10° to the right and left and 10° up and down
- 4 tertiary positions of 10° up and right, up and left, down and right, and down and left.

The amounts of vertical deviation were also measured by tilting the patients' head 30° towards each shoulder. Both primary deviation (non-paretic eye fixation) and secondary deviation (paretic eye fixation) were measured for both near and distance fixation as appropriate.

The amounts of horizontal and vertical deviation were measured objectively using the prism and cover test (PCT) and subjectively using the Maddox rod and prism test (MT). For the PCT, which measured the magnitude of tropia (manifest deviation), patients fixated at a 6/18 Snellen symbol at 6 m and a cover was placed in front of one eye while the patients fixated with the other eye. Prisms of increasing power were used not only until refixation movement had stopped but also until a reversal of the direction of movement was noted. The increase in prism strength was tailored to each patient and was not performed in uniform steps. The highest prism strength used immediately before the reversal of refixation movement was recorded.

The MT measured the magnitude of phoria (latent deviation). For horizontal deviation, a red Maddox rod was placed over 1 eye with the small glass rods oriented horizontally, while the patients fixated on a small white light at a distance of 6 m. Prisms of increasing strength were used until the red streak was reported to go through the white light. Vertical deviation was measured with the small glass rods oriented vertically.

Data Analysis

Consistent with paralytic strabismus, all patients had an incomitant esodeviation, which increased in the field of deviation of action of the paretic muscle. Only the primary deviations are reported as the results with the secondary deviations were similar. The mean deviations and the standard deviation were calculated for both the objective PCT measurements and the subjective MT measurements for both the horizontal and vertical strabismus components. Correlation between the abduction deficit and the magnitude of hyperdeviation was assessed using linear regression. The hyperdeviation was assessed by both tests in either side head tilt. Independent samples test and Mann-Whitney test were used to examine the relationship between the side of palsy and the side of hyperdeviation.

Results

All the participants had a clinically proven isolated peripheral unilateral abducens palsy. The mean age was 56 years (SD, 10 years; range, 28 to 66 years; median, 59 years). Twelve patients were men and 8 were women. The mean duration of symptoms was 12 months (SD, 8 months; range, 1 week to 32 months). The mean follow-up duration was 8 months (range, 4 to 10 months). Neuroimaging was normal for all patients. Fourteen patients had an associated ischaemic risk factor of diabetes mellitus or hypertension, which was well controlled.

The mean horizontal deviation was 22.7 pd (SD, 11.9 pd; range, 16.0 to 38.0 pd) on PCT. Hyperdeviation was present in all patients. Mean vertical deviation on PCT was 5.0 pd (SD, 2.1 pd; range, 3.0 to 8.0 pd) in the primary position. The mean vertical deviation on subjective testing by MT was 5.7 pd (SD, 2.7 pd; range, 3.0 to 8 pd). Head tilt to the affected side revealed a mean vertical deviation of 4.6 pd (SD, 2.4 pd; range, 3.0 to 8.0 pd) and head tilt to the non-affected side resulted in mean deviation of 4.8 pd (SD, 1.9 pd; range, 3.0 to 7.0 pd) with PCT. On subjective testing with MT, the mean vertical deviation was 5.0 pd (SD, 2.6 pd; range, 3.0 to 8.0 pd) on head tilt to the affected side, and 5.1 pd (SD 2.6 pd; range, 3.0 to 8.0 pd) on head tilt to the non-affected side. Mann-Whitney test revealed a p value of 0.495 for PCT and 0.909 for MT. No significant difference was found between head tilt to the affected and unaffected side.

Discussion

A hyperdeviation was present in all patients with isolated abduction deficit in this study. Although the magnitude of hyperdeviation fell within the normal range of hyperphoria, thus excluding multiple cranial nerve palsies or brain stem lesions, it was clinically significant in the unexplained vertical component of the diplopia it produced in a few representative patients. This correlated well with previous reports of hyperdeviation being significant in primary gaze and in the field of gaze of the paretic lateral rectus muscle.[1,2]

Wong et al found a distinct pattern of vertical misalignment using the MT in patients with peripheral sixth nerve palsy.[4] In peripheral palsy, right head tilt was associated with right

hyperdeviation, and left head tilt was associated with left hyperdeviation. In contrast, in central palsy, the side of hyperdeviation did not change on head tilt to either side. However, there was no such relationship with head tilt in peripheral sixth nerve palsy in the patients in this study. However, no scleral search coils were used and this study was purely clinical.

The previous lack of recognition of a vertical deviation in such cases may be due to several factors.[4] The MT may not be routinely used for quantification of vertical binocular imbalance in patients with abducens palsy without accompanying vertical muscle limitation or other neuro-ophthalmological signs. Secondly, the small hyperdeviation in the primary gaze detected with the PCT may be overshadowed by a larger esodeviation that is invariably present.

Kestenbaum stated that a vertical component may be found in some patients with isolated abducens palsy.[3] This author proposed that there may also be a slight inhibitory effect on vertical movements of the eye. A slight vertical deviation in abducens paresis, which was sometimes noted, was thought to be due to the fact that the eye can be elevated or depressed more than the normal in the direction of the paretic muscle. The incidence or magnitude of the hyperdeviation was not addressed, although 2 to 3 pd of vertical deviation may accompany the abducens palsy.

The static head tilt stimulates receptors in the macula of the utricle leading to ocular counter-roll and a small change in the vertical alignment in healthy people.[4-6] Roll of the head about its naso-occipital axis activates the torsional vestibule-ocular reflex, causing the eyes to rotate around their visual axes. However, when the otolith-ocular reflex pathway is disrupted, ocular torsion and skew deviation are observed.[6,7] This indicates that, under normal circumstances, the otolith-ocular reflex is symmetrical and balanced; it is also suppressed during static head roll. This suppression is probably mediated, in part, by visual mechanisms. Disruption of binocular vision may remove the suppression on the otolith-ocular reflex and lead to the pattern of right hyperdeviation on right head tilt and left hyperdeviation on left head tilt observed in patients with isolated abducens palsy.[4,6,7]

Since most patients with sixth nerve palsy recover within 3 months, they require little investigation at the time of initial presentation if they have no other neurological features, hypertropia falls within the normal range of hyperphoria seen in healthy people, indicating that it is a normal hyperphoria that becomes manifest in the presence of esotropia. In healthy people, the mean vertical deviation in the straight ahead position is 1.5 pd (SD, 1.5 pd).

The magnitude of the vertical misalignment changes with lateral head tilt, but the hyperdeviation does not correlate significantly to the side of the abduction deficit or to the side of the lateral head tilt. The diagnostic position in which the hyperdeviation was most marked did not correlate significantly with the side of the abduction deficit as has previously been reported.

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The Prevalence and Causes of Visual Impairment and Common Ocular Disorders in the United Arab Emirates: a Hospital-based Study

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Aim: *To determine the prevalence and causes of visual impairment in Al-Ain, the United Arab Emirates.*
Methods: *This was a descriptive population-based study performed at 2 hospitals. Of 2500 potential participants recruited between October 2001 and June 2002, 1686 (67.4%) gave their consent to participate in the study. Interviews, visual acuity testing, and an extensive eye examination were performed for each participant. The World Health Organization/Prevention of Blindness proforma and its classification system were used for identifying the main cause of low vision and blindness in each patient. The definitions of blindness (visual acuity <3/60) and low vision (visual acuity between <6/12 and >3/60) were based on the presenting visual acuity in the better eye.*
Results: *The mean age of the participants was 32.2 years. Most participants (91.9%) had normal vision, while 4.0% had visual impairment, 3.3% had low vision, and 0.8% were blind. Ocular disorders were present in 19.3% of the participants. Refractive error was the most common disorder (6.2%), followed by inactive and active trachoma (3.9%) and chalazion (2.3%).*
Conclusion: *Uncorrected refractive error is a major cause of visual impairment in this population, although these conditions are preventable. This survey indicates the need for the development and implementation of a national plan for the delivery of effective eye care services. The results also highlight the need for visual impairment prevention programmes, with emphasis on treatment of refractive errors.*

Key words: *Blindness, Epidemiology, Low vision, Prevalence, United Arab Emirates, Vision disorders*

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Introduction

Visual impairment is a global public health problem. According to the World Health Organization (WHO), worldwide there are an estimated 45 million people who are blind, with an additional 135 million individuals who are visually impaired.[1] Globally, it is known that cataract is the leading cause of blindness, with some 16 to 20 million people having blinding cataract.[2] The majority of visually impaired people in the world live in the developing nations of Africa, Asia, and Latin America and it is known that almost three-quarters of the world's blindness is either curable or preventable.[3] Therefore, controlling the problem of visual impairment is a priority for these countries. There are numerous studies of the prevalence of visual impairment in various regions of the world,[4-19] including eastern Mediterranean countries.[3,4,6,8] However, the epidemiology of visual impairment is complicated, encompassing a wide variety of factors, and strategies for controlling the problem need to be region specific, based on data from that community. There are very few published studies of the prevalence of visual impairment in the Arabian population.[3,4,6,8]

No previous study has been conducted in the United Arab Emirates (UAE). The absence of reliable population-based

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epidemiological data about blindness and low vision in the UAE is a serious impediment to effective national planning of eye care programmes. The aim of the present study was to determine the prevalence of visual impairment and its major causes in the population of Al-Ain, UAE.

Methods

Participants

According to the 2002 Annual Report of the Ministry of Health, Abu Dhabi, the estimated population of the city of Al-Ain was approximately 400,000. The study target population for this population-based study, the Emirati Eye Study, included urban and semi-urban regions and citizens of all ages who resided in Al-Ain city in 2002. Potential participants were recruited between October 2001 and June 2002. Approval for the study to be carried out as a routine screening programme was obtained from the Chairman of the Ophthalmology Department at each of the 2 participating teaching hospitals, the Al-Ain and Tawam Hospitals in Al-Ain. Informed consent was obtained verbally from each participant after an explanation of the aims and the nature of the study and procedures involved. A signed consent form was obtained from the parent or guardian of each child. All patients were invited for a complete eye examination at the Al-Ain or Tawam Hospitals.

Taking into account design effect and response rate, a sample size of 2500 was calculated to estimate an expected prevalence of 2% with a precision of 0.5% and a confidence level of 95%. Accordingly, 2500 potential participants were recruited by a simple random process from the residents of the city of Al-Ain and from people who visited the Al-Ain and Tawam Hospitals during the period of the study. Overall, 1686 (67.4%) gave consent to participate in the study. Reasons for non-participation were inability to attend scheduled appointments, loss to follow-up, lack of time, and lack of interest.

Procedure

All participants received thorough eye examinations. The data were collected by trained nurses and supervised by one of the investigators, who is an ophthalmologist. The examination protocol included visual acuity measurements; manifest, subjective and cyclopaedic refraction; colour vision testing; Goldmann applanation tonometry; lensometry; examination of the external eye, anterior segment, media, and fundus; and an interview for demographic characteristics, past history of eye diseases, eye trauma, diabetes mellitus, hypertension, and any previous ophthalmological care. Visual acuity was determined by using a Nidek Auto Refractor Gradiometer (ARC-700A; Nidek, Gamagori, Japan) with tumbling E letters at a distance of 4 m. The participants' visual acuity without correction was measured separately for each eye and presenting acuity was measured with the participants' habitual distance correction. Visual acuity was then tested with best spectacle correction. Visual acuity was recorded as the line with the smallest print that the participant could read 4 letters correctly. If the participant was unable to read the largest E letters in the chart (20/400 E letters) at 4 m, then finger counting was assessed. The examiner stood 1 m in front of the participant and asked if their hand was visible. The examiner slowly waved their hand and asked the participant if they could see what the hand was doing. If they could see the examiner's hand moving, 'hand motion' was recorded on the examination form.

In addition, an interobserver comparison of visual acuity assessment between the optometrists was carried out for 256 eyes during the study, 18 of which had visual acuity less than 6/18. There was agreement for 245 (95.7%) of the 256 eyes in terms of assigning eyes to the categories of normal or low vision, or blind, defined below ($\kappa = 0.83$).

Definitions

This survey used the WHO and International Classification of Diseases, 10th edition, definitions of blindness, low vision, and visual impairment.[20] These are based on assessment of visual acuity in the better eye with best correction. Visual impairment is defined as a visual acuity of <6/18 (20/60,0.3) and further categorised as blindness (visual acuity of <3/60 or inability to count fingers at a distance of 3 m) or low vision (visual acuity of <6/18 but ≥3/60). Cataract was regarded as the main cause of severe low vision if the fundus was obscured by lens changes or if no evident fundus abnormalities were observed in eyes with significant cataract. Refractive errors were regarded as present if visual impairment improved to ≥6/18 with a pinhole, with no evidence of cataract by torchlight examination. Retinal diseases were defined as retinal

Table 1. Characteristics of the study participants compared with the population of the United Arab Emirates (UAE).

Characteristic	Study participants Number (%)	UAE population* Number of participants (%)
Age group (years)		
0-9	55 (3.3)	652,894 (17.4)
10-19	215 (12.8)	539,671 (14.4)
20-29	419 (24.9)	858,916 (22.9)
30-39	467 (27.7)	953,875 (25.4)
40-49	404 (24.0)	533,768 (14.2)
50-59	107 (6.3)	154,215 (4.1)
60-70	19 (1.1)	60,661 (1.6)
Sex		
Male	1125 (66.7)	2,543,000 (67.7)
Female	561 (33.3)	1,211,000 (32.3)
Total	1686	3,754,000

* Estimates based on Ministry of Health, Annual Report 2002, Abu Dhabi, United Arab Emirates.

Table 2. Sociodemographic characteristics of the study participants.

Characteristic	Number of participants (%)
Nationality	
United Arab Emirates	810 (48.0)
Other	876 (52.0)
Marital status	
Single	627 (37.2)
Married	978 (58.0)
Divorced/widowed	81 (4.8)
Educational level	
Illiterate	302 (17.9)
Primary	537 (31.9)
Intermediate	210 (12.5)
Secondary	455 (27.0)
University	182 (10.8)
Occupation	
Sedentary	264 (15.7)
Manual worker	414 (24.6)
Businessman	293 (27.4)
Student	219 (13.0)
Housewife	339 (20.1)
Retired/not working	46 (2.7)
Army/police	111 (6.6)

abnormalities caused by dystrophy, degeneration, or acquired metabolic causes such as diabetes mellitus. Glaucoma was defined as the presence of a vertical cup-disc ratio of 0.4 or more, together with an intraocular pressure of more than 22 mm Hg.[18] Corneal disease was defined as loss of normal corneal transparency due to any cause involving the central cornea. When 2 causes appeared to be contributing equally to visual impairment the primary cause was considered to be the one that was amenable to treatment to restore vision.

Statistical Analysis

Chi squared analysis was performed to test for differences in proportions of categorical variables between 2 or more groups. Prevalence values are reported with 95% confidence intervals. A p value of <0.05 was considered significant.

Results

The age and gender distribution of the study population were assessed and found to be representative of the general population of Al-Ain, UAE (Table 1). The mean age of the participants was 33.3 years for men and 30.4 years for women. Table 2 shows other sociodemographic characteristics of the study population. Table 3 gives the prevalence of visual impairment, low vision, and blindness according to sex, age group, nationality, and level of education. Most participants (91.8%) were found to have normal vision, while 4.0% had visual impairment and 3.4% had low vision. The prevalence of blindness was very low (0.8%).

The frequency of various ocular disorders among the participants is shown in Table 4. Of 1686 participants, 325 had ocular disorders (19.3%). Refractive error was the most common disorder encountered (6.2%), followed by inactive and active trachoma (3.9%) and chalazion (2.3%).

Discussion

The Emirati Eye Study was performed to investigate eye disorders in the UAE. This is the first report of a survey of visual impairment in this region. The prevalence of blindness and low vision found in

Table 3. Prevalence of visual impairment, low vision, and blindness according to sex, age, nationality, and occupation.

Variable	Number of participants	Prevalence (95% confidence interval) [%]			
		Normal vision	Visual impairment	Low vision	Blindness
Sex					
Men	1125	61.50 (59.1-63.8)	2.60 (1.9-3.4)	2.10 (1.5-2.9)	0.5 (0.2-1.0)
Women	561	30.30 (28.1-32.6)	1.40 (0.9-2.1)	1.20 (0.8-1.9)	0.3 (0.1-0.7)
Age (years)					
0-9	55	2.90 (2.2-3.8)	0.2 (0.03-0.5)	0.20 (0.04-0.5)	0
10-19	215	12.00 (10.5-13.6)	0.40 (0.2-0.9)	0.40 (0.1-0.8)	0
20-29	419	22.80 (20.8-24.9)	0.50 (0.2-1.0)	1.20 (0.8-1.9)	0.30 (0.09-0.7)
30-39	467	26.10 (24.0-28.3)	1.10 (0.6-1.7)	0.40 (0.2-0.9)	0.10 (0.01-0.4)
40-49	404	21.50 (19.5-23.5)	1.20 (0.8-1.9)	0.90 (0.5-1.5)	0.30 (0.09-0.7)
50-59	107	5.60 (4.6-6.8)	0.50 (0.2-0.9)	0.10 (0.01-0.4)	0.10 (0.01-0.4)
60-70	19	0.90 (0.5-1.5)	0.06 (0.001-0.3)	0.10 (0.01-0.4)	0
Nationality					
United Arab Emirates	810	44.20 (41.8-46.6)	1.80 (1.2-2.6)	1.80 (1.2-2.5)	0.20 (0.06-0.6)
Other	876	47.60 (45.2-50.0)	2.10 (1.5-2.9)	1.60 (1.1-2.3)	0.60 (0.3-1.0)
Educational level					
Illiterate	302	16.00 (14.3-17.9)	0.80 (0.5-1.4)	0.90 (0.5-1.5)	0.20 (0.04-0.5)
Primary	537	29.40 (27.3-31.7)	1.50 (1.0-2.1)	0.80 (0.4-1.3)	0.20 (0.04-0.5)
Intermediate	210	11.70 (10.4-13.5)	0.30 (0.1-.7)	0.20 (0.06-0.6)	0.06 (0.0-0.3)
Secondary	455	24.70 (22.6-26.8)	1.00 (0.5-1.5)	0.90 (0.5-1.5)	0.40 (0.2-0.9)
University	182	9.80 (8.5-11.4)	0.40 (0.2-0.9)	0.50 (0.2-0.10)	0
Total	1686	91.80 (90.4-93.1)	4.00 (3.1-5.0)	3.40 (2.6-4.4)	0.8 (0.5-1.4)

Table 4. Frequency of ocular disorders among study participants.

Diagnosis	Number of participants (%)
No disorders	1361 (80.7)
Refractive error	104 (6.2)
Chalazion	39 (2.3)
Inactive trachoma	36 (2.1)
Active trachoma	31 (1.8)
Vitreo-retinal disorders	28 (1.7)
Vernal keratoconjunctivitis	27 (1.6)
Amblyopia	23 (1.4)
Corneal opacity	19 (1.1)
Senile cataract	18 (1.1)

the Emirati Eye Study is lower than those reported for some other countries (Table 5).[8,9,11,14-17] However, comparisons among studies should be treated with caution as the results are sensitive to the definitions used and the population studied. The Emirati Eye Study involved an urban/semi-urban population, with better access to health care services such as cataract surgery than are available in other parts of the country. As the age distribution of the population can strongly influence the overall estimate of visual impairment, it should be noted that the UAE has a relatively young population.

To compare the results with other studies, the data collected in the present study were evaluated using the WHO criteria for visual impairment, but the functional limitations caused by poor vision occurring at relatively high levels of visual acuity seem to be underestimated by this definition.[1,20]

Since visual impairment due to uncorrected or under-corrected refractive error is not noted when using the WHO best-corrected visual acuity definition, the results were presented based on presenting visual acuity with available correction. This definition gives the 'real' magnitude of visual impairment in a population.[9] Using the definition of visual impairment based on presenting visual acuity permitted the assessment of visual impairment due to refractive errors, which were the most prevalent causes of visual impairment, especially low vision.

In other population-based studies, cataract was the leading cause of visual impairment defined on the basis of best-corrected visual acuity.[5,6,8-18] However, refractive errors were the principal cause of visual impairment when presenting visual acuity was used in this study. Refractive errors are also one of the leading causes of visual impairment in other parts of the world.[1-3] The burden of visual impairment due to refractive errors in terms of visually impaired person-years is more serious than the numbers indicate, since refractive error-related visual impairment generally starts at a young age and causes a significant economic and social burden.[4]

Consistent with other studies,[4,6,8,13-15] visual impairment was associated with advancing age and lower education in the present study. This association was evident among both men and women and at different levels of education. However, the association was stronger for low vision than for blindness and with the definition of visual impairment based on best-corrected visual acuity.

Some limitations of the present study must be acknowledged. First, although the total sample size was appropriate to estimate the prevalence in the population, the desired level of precision was not always obtained for some of the estimates in the age and sex groups. Secondly, despite the acceptable response rate (67.4%), the prevalence of visual impairment may have been overestimated because those participants who chose not to enrol in the study were less likely to have impaired vision. On the other hand, since prevalence estimates were based only on visual acuity measurements, some visual impairment associated with visual field defects could have been missed, resulting in a potential underestimation. In addition, because the study was carried out among a hospital-based population, with special socioeconomic characteristics, the results cannot be extrapolated to the population of the country.

The results of the present study indicate that the burden of visual impairment is important and, although easily preventable, uncorrected refractive errors have a major role as causes of visual impairment in this population. This survey indicates the need for the development and implementation of a national registry plan

Table 5. Prevalence of blindness in selected countries.

Country	Sample size	Age (years)	Definition	Prevalence
Lebanon[6]	10148	≥3	<3/60	0.60
Nepal[9]	4602	≥45	<6/60	5.30
China[11]	5342	≥50	<6/60	4.37
Hong Kong[14]	3441	≥60	<3/60	1.80
Equatorial Guinea[15]	3218	All	<3/60	3.20
India[16]	5411	≥50	<3/60	4.10
Malaysia[18]	18027	All	<3/60	0.29
Oman[8]	11417	All	<3/60	1.10
Turkmenistan[17]	6011	≥50	<3/60	1.26
Iran[4]	4565	All	<3/60	0.39
United Arab Emirates*	1686	All	<3/60	0.80

* Current study.

for the delivery of effective eye care services. The results highlight the need for visual impairment prevention programmes, with an emphasis on treatment of refractive errors, and the need to target high-risk groups.

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Bilateral Spontaneous Scleral Perforation in Marfan's Syndrome

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Ocular manifestations of Marfan's syndrome include lens subluxation, retinal detachment, and myopia. Scleral perforation after trabeculectomy and scleral buckling procedure have been reported but spontaneous perforation is rare. This report is of a patient with Marfan's syndrome who had bilateral spontaneous scleral perforation. Surgical repair of the defect with frozen scleral graft was required.

Key words: *Marfan syndrome, Sclera, Transplants*

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Introduction

Marfan's syndrome is a hereditary generalised connective disease. Ocular manifestations include lens subluxation, retinal detachment, and myopia.[1,2] Scleral perforation after trabeculectomy and scleral buckling procedure have been reported in patients with Marfan's syndrome[3,4] but spontaneous perforation has not been described in the literature. This report is of a patient with bilateral spontaneous scleral perforation requiring surgical repair with a scleral patch graft.

Case Report

An 18-year-old man with Marfan's syndrome presented with bilateral red eye and tearing for 1 week. He had no history of trauma or previous ocular surgery. The visual acuity was 20/40 in both eyes with myopic glasses of more than -10.00 D. The intraocular pressure (IOP) was 9 mm Hg in the right eye and 8 mm Hg in the left eye. The corneas were normal in shape. The anterior chambers were very shallow and the pupils were distorted upward. There was upward subluxation of the microspherical lens in both eyes. There were areas of scleral thinning in the superior quadrants of both eyes with exposed uveal tissue covered by a layer of thin conjunctival epithelium (Figures 1a and 1b). No transconjunctival aqueous leak was demonstrated with the Seidel test. The posterior segments were normal. Ultrasound biomicroscopy (UBM) showed

Figure 1. Slit-lamp photograph showing the site of scleral perforation with uveal tissue prolapse in (a) the right eye; and (b) the left eye.

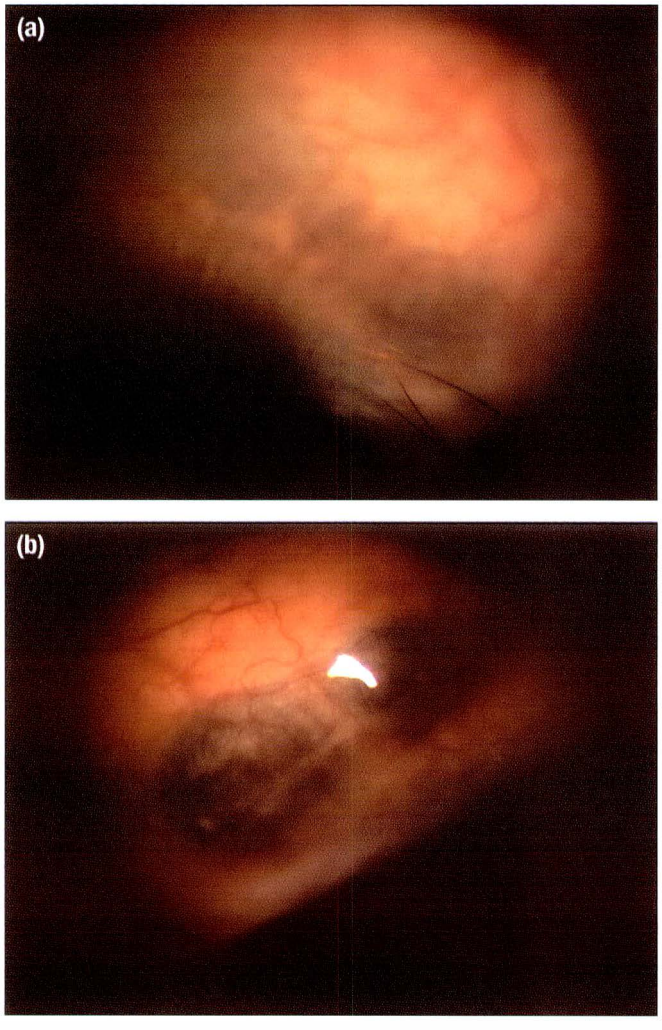

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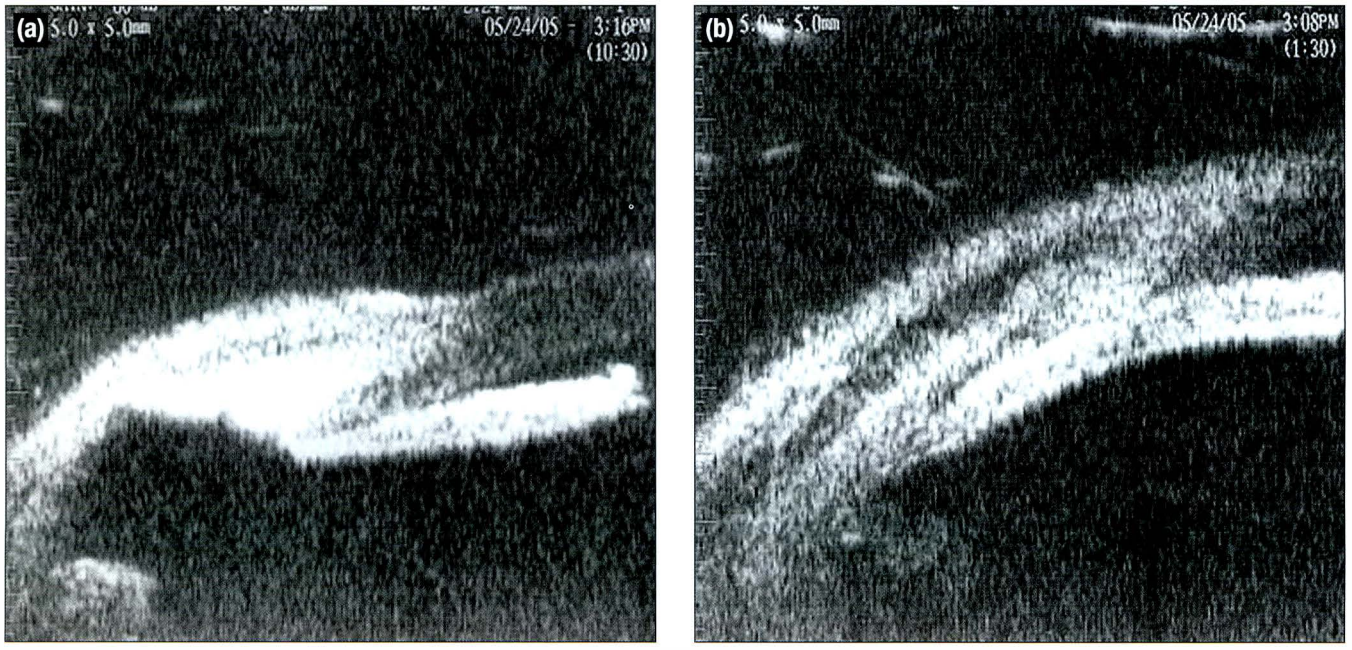
Figure 2. Ultrasound biomicroscopy showing (a) area of scleral thinning; and (b) cystic areas in the conjunctiva and the subconjunctival space.

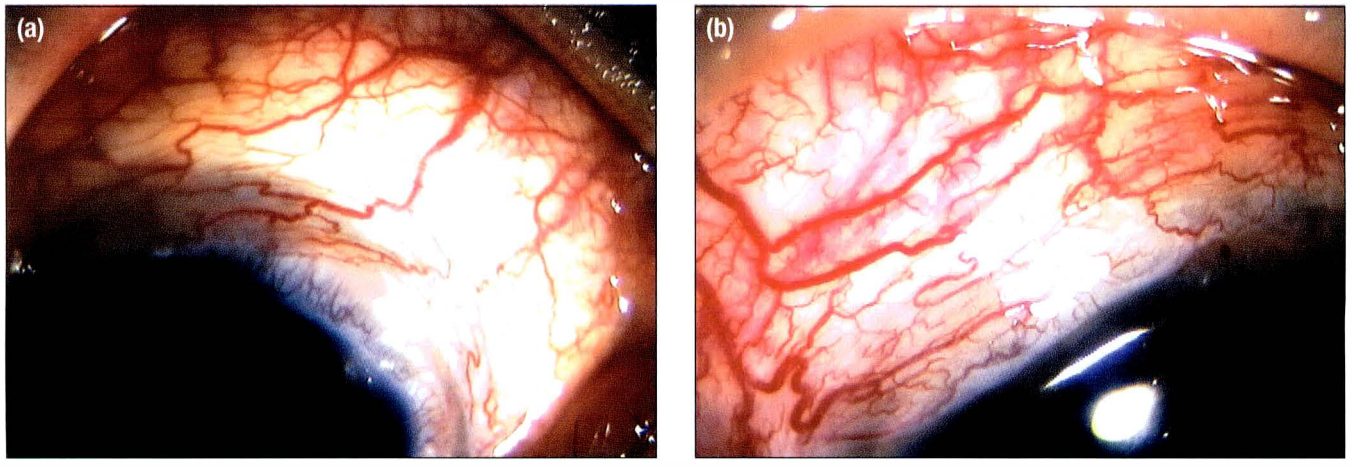


scleral thinning and cystic changes in the subconjunctival spaces around the lesions (Figures 2a and 2b). Surgical repair with frozen corneoscleral patch graft was performed for both eyes. Periotomy was performed in the superior quadrant. The corneal portion of the graft was removed. The edges of the scleral graft were trimmed to form smooth sloping edges. The graft was sutured with interrupted 10/0 nylon to the recipient sclera and peripheral cornea. A paracentesis wound was made and the anterior chamber was reformed with balanced salt solution and the site of uveal prolapse was examined for aqueous leakage. The conjunctiva was closed with interrupted 8/0 vicryl sutures. Topical antibiotic was prescribed after surgery. The anterior chamber remained shallow in the first 2 postoperative days and there was aqueous oozing at the edge of the graft-host interface. The leak stopped after a few days. Five months after the surgical repair, the visual acuity was 20/40 in the right eye and 20/30 in the left eye. The IOP was 13 mm Hg in the right eye and 10 mm Hg in the left eye. The grafts healed well and the anterior chambers were well maintained (Figures 3a and 3b).

Discussion

Spontaneous scleral perforation is unusual in Marfan's syndrome although the scleras in these patients are usually thin. In this patient, no precipitating factor such as trauma, inflammation, previous ocular surgery, or chronic increase in IOP was found to account for the scleral perforation. Fibrillin is found in normal sclera and mutation in the fibrillin gene on chromosome 15 causes Marfan's syndrome.[5] The altered fibrillin gene product may be responsible for the thinning of the sclera.[6] The altered fibrillin molecule may

Figure 3. Slit-lamp photograph showing the postoperative appearance of (a) the right eye; and (b) the left eye.



allow mechanical stretching of the sclera and account for the high myopia. The abnormal sclera became progressively thinner over time and perforated spontaneously. The aqueous leaked through the scleral defect and accumulated under the conjunctiva resulting in cystic changes as shown with UBM. In view of the hypotony and the flat anterior chamber, surgical repair using frozen corneoscleral graft was performed. Successful repair of similar defects with scleral graft and amniotic membrane has been reported.[7] Although there was transient aqueous leak in the early postoperative period, the grafts healed well and the IOP normalised. However, it would be interesting to see the long-term outcome of the graft and whether there is recurrence of the scleral perforation. Patients with Marfan's syndrome should be informed of the risk of spontaneous scleral perforation in addition to the other known ocular manifestations.

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Bilateral Traumatic Dislocation of Lens and Giant Retinal Tears in a Patient with Tourette's Syndrome

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Tourette's syndrome commonly presents with self-injurious behaviour. This report is of a 51-year-old man with bilateral traumatic lens dislocation and giant retinal tears secondary to repetitive self-inflicted injury.

Key words: *Retinal detachment, Retinal perforations, Self-injurious behaviour, Tourette syndrome*

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Introduction

Tourette's syndrome is a neuropsychiatric disorder that commonly presents with self-injurious behaviour. This report is of a patient with Tourette's syndrome who presented with bilateral traumatic lens dislocation and giant retinal tears secondary to repetitive self-inflicted injury.

Case Report

A 51-year-old man with Tourette's syndrome was referred to the Department of Ophthalmology, Selayang Hospital, Selangor, Malaysia, in 2004 with a 2-week history of bilateral sudden-onset painless loss of vision. He had been diagnosed with Tourette's syndrome at the age of 30 years and was taking antidepressants to control the tics. The motor tic involved involuntary behaviour of repeatedly jabbing his fingers, punching his fist into his eyes, and spitting. He did not have myopia.

At presentation, his visual acuity was 2/60 in both eyes. Both eyes were aphakic with clear crystalline lens dislocated into the vitreous cavity inferiorly. The right eye showed superior bullous rhegmatogenous retinal detachment, which spared the macula. In the left eye, there was extensive partial avulsion of the vitreous base with detachment of the non-pigmented epithelium of the pars plana. Otherwise, the left retina was flat. General examination revealed an alert and well-oriented man with repetitive movements involving eye punching and spitting. There were no features suggestive of Marfan's syndrome or Weil-Marchesani syndrome.

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A right vitrectomy, removal of the dislocated lens, endolaser, and 16% perfluoropropane gas tamponade was performed under general anaesthesia. Intraoperatively, there was a subtotal right retinal detachment with a giant retinal tear from 12 o'clock to 3 o'clock and multiple small tears from 4 o'clock to 5 o'clock. There was also a partial avulsion of the vitreous base with corresponding detachment of the non-pigmented epithelium of pars plana from 1 o'clock to 5 o'clock. The macula was attached (Figure 1).

Figure 1. Diagram of the right eye showing a subtotal retinal detachment with a giant retinal tear from 12 o'clock to 3 o'clock and multiple small tears from 4 o'clock to 5 o'clock. There was also a partial avulsion of the vitreous base with corresponding detachment of the non-pigmented epithelium of pars plana from 1 o'clock to 5 o'clock. The macula was attached.

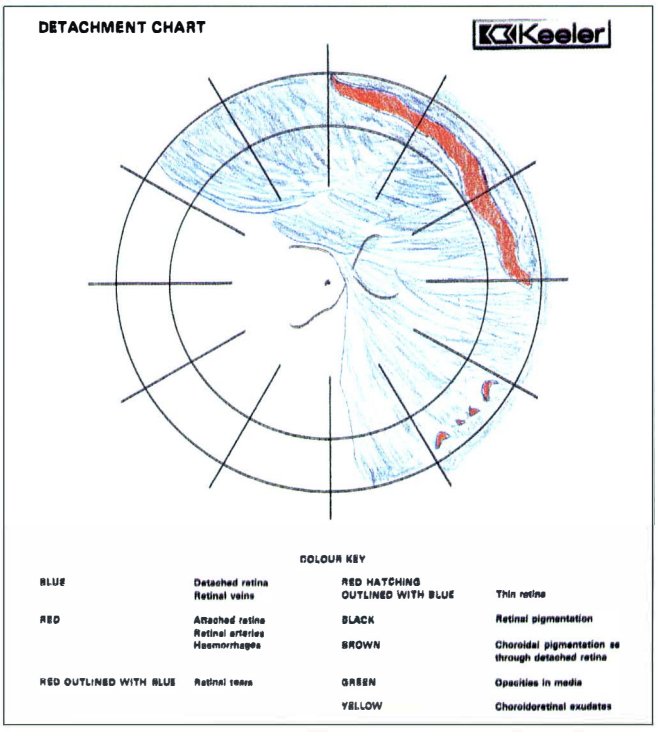
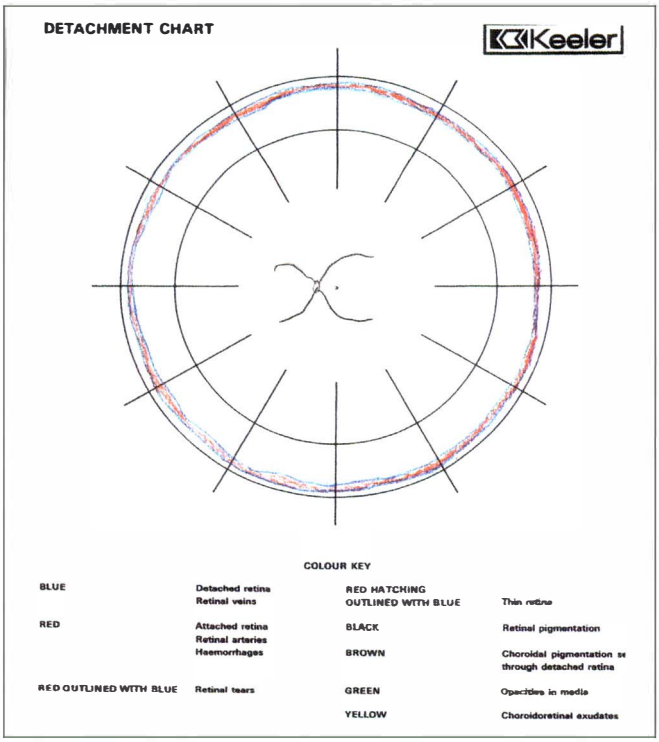


Figure 2. Diagram of the left eye showing 360° partial avulsion of the vitreous base with corresponding detachment of the non-pigmented epithelium of pars plana with a 360° giant retinal tear. The retina and the macula were attached.



Two days later, a left vitrectomy, removal of the dislocated lens, endolaser, and silicone oil tamponade was performed. There was 360° partial avulsion of the vitreous base with corresponding detachment of the non-pigmented epithelium of pars plana with a 360° giant retinal tear. Fortunately, the retina and the macula were attached (Figure 2). An intraocular lens was not implanted in view of his self-injurious behaviour.

Six weeks postoperatively, the patient developed bilateral secondary glaucoma and was successfully treated with anti-glaucoma medications.

Removal of silicone oil for the left eye was performed under general anaesthesia 3 months after retinal attachment surgery. Postoperatively, the retina in both eyes was flat. With aphakic correction, he could achieve best-corrected visual acuity of 6/9 in the right eye and 6/18 in the left eye.

He was counselled about prevention of further ocular injuries and advised to wear protective goggles.

Discussion

Tourette's syndrome was first described in 1885 by a French physician Georges Gilles de la Tourette.[1] Tourette's syndrome is a neuropsychiatric disorder of childhood-onset that consists of multiple motor and vocal tics. The disease affects approximately 1:2000 people worldwide.[2] Tics, the hallmark of Tourette's syndrome, are defined as involuntary, sudden, rapid, repetitive, non-rhythmic, stereotyped movements or vocalisations. Motor involvement can range from an eye blink to complex tics such as hitting and jumping. Vocal tics include sounds such as grunting, barking, echolalia (repetition of other people's words) or coprolalia (uttering of obscene words).[1]

Self-injurious behaviour occurs in up to 60% of patients with Tourette's syndrome.[2] A variety of self-injurious behaviours have been reported in individuals with Tourette's syndrome, including compulsive skin picking, self-hitting, self-biting, filing of teeth, head banging, and self-eye poking.[2] Eye injuries resulting from self-injurious behaviour can range from minor corneal injuries to posterior segment involvement.[3-5] Lim et al reported a patient with Tourette's syndrome with self-injurious behaviour who presented with bilateral retinal detachment.[4] This patient had motor tics demonstrated by excessive blinking, blepharospasm, clapping, jabbing his fingers into his eyes, and punching himself in the periorbital area. However, to date, a patient with bilateral simultaneous lens dislocation and retinal detachment occurring secondary to self-injurious behaviour has not been reported.

This patient clearly demonstrated motor tics that predisposed him to blunt ocular trauma. There were no other obvious risk factors, either ocular or systemic, to suggest a different aetiology for the lens dislocation, giant retinal tear, and retinal detachment.[6] These authors recommend the use of protective goggles for patients with Tourette's syndrome with self-injurious behaviours to avoid ocular injuries. Prevention of blunt ocular trauma can also be achieved by co-management with psychiatrists for medical treatment to control tics.

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Corneal Endothelial Cell Loss following Chemical Injury

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This report is of a 24-year-old man with bilateral corneal endothelial cell loss following chemical injury with nitrous acid and selenium dioxide. Vision at presentation was 20/400 and 20/200 in the right and left eyes, respectively. Six months after the injury, the ocular surface appeared stable in both eyes. He regained 20/20 visual acuity in the right eye, but the vision in the left eye was 20/600 due to persistent corneal oedema and scarring. Confocal microscopy showed reduced endothelial cell density of 771 cells/mm³ in the right eye. Fourteen months later, he underwent penetrating keratoplasty in the left eye. Histopathology revealed significant loss of keratocytic nuclei and complete absence of endothelial cells.

Key words: *Endothelium, corneal, Eye burns, Keratoplasty, penetrating, Nitrous acid, Selenium oxide*

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Introduction

Ocular damage due to chemical injury may lead to permanent visual impairment.[1] The extent of the injury depends on the exposure time and the toxicity of the chemical.[2] This report is of a patient with bilateral endothelial cell loss following acid injury.

Case Report

A 24-year-old man who worked as a supervisor at a chemical-manufacturing unit presented to the Comprehensive Ophthalmology Services, LV Prasad Eye Institute, Hyderabad, India, in 2003, the day after nitrous acid mixed with selenium dioxide had fallen in his eyes. His visual acuity at presentation was 20/400 and 20/200 in the right and left eyes, respectively. Examination showed severe bilateral lid oedema and conjunctival chemosis, but there was no ulceration or excoriation of the skin. The corneas showed grey necrotic epithelium, which subsequently sloughed off, leading to total epithelial defects. There were no areas of limbal ischaemia. Stroma showed 3+ oedema (Figure 1a) that precluded view of the anterior chamber, lens, and posterior segment. B-scan ultrasonography revealed choroidal thickening.

He was treated with immediate copious saline irrigation, oral and topical corticosteroids, cycloplegics, and lubricants. During the next 6 months, he regained 20/20 vision in the right eye. The ocular surface in both eyes appeared stable, with intact corneal epithelium. There was no corneal neovascularisation or conjunctivalisation. The right corneal endothelium showed guttate changes, and the left cornea showed persistent corneal oedema. One year later, confocal microscopy of the right eye showed a count of 771 cells/mm³, with 55% polymegathism and 35% pleomorphism. Images from the left eye could not be obtained due to significant oedema. Subsequently, the patient developed bullous keratopathy and scarring in the left eye (Figure 1b), for which he underwent penetrating keratoplasty 14 months after injury. Preoperative visual acuity was 20/600. One month after surgery, the graft was clear and his visual acuity had improved to 20/100 (Figure 2a). Histopathology of the excised cornea showed significant loss of stromal keratocytes. Descemet's membrane showed complete absence of endothelial cells (Figure 2b).

Discussion

Conjunctival and corneal epithelial damage due to acid injury have been well documented.[1] In general, acid injuries tend to be less severe, as they remain confined to the epithelial surface, producing more superficial damage.[3] In this patient, the eventual recovery of the ocular surface can be explained by the chemical nature of nitrous acid and selenium dioxide (weak acids). Selenium dioxide converts to seleniferous acid only on exposure to water or tears. This gas has been reported to produce only minor ocular irritation and superficial skin burns.[4] Wesley and Collins reported pseudopterygium following selenium dioxide exposure.[4]

For this patient, the authors hypothesise that some degree of deeper ocular penetration occurred by this combination of chemicals, leading to significant uveitis (as evidenced by choroidal

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Figure 1. Slit-lamp photograph of the left eye (a) 1 month after injury showing corneal oedema; and (b) the same eye 1 year later with corneal scarring and bullae.

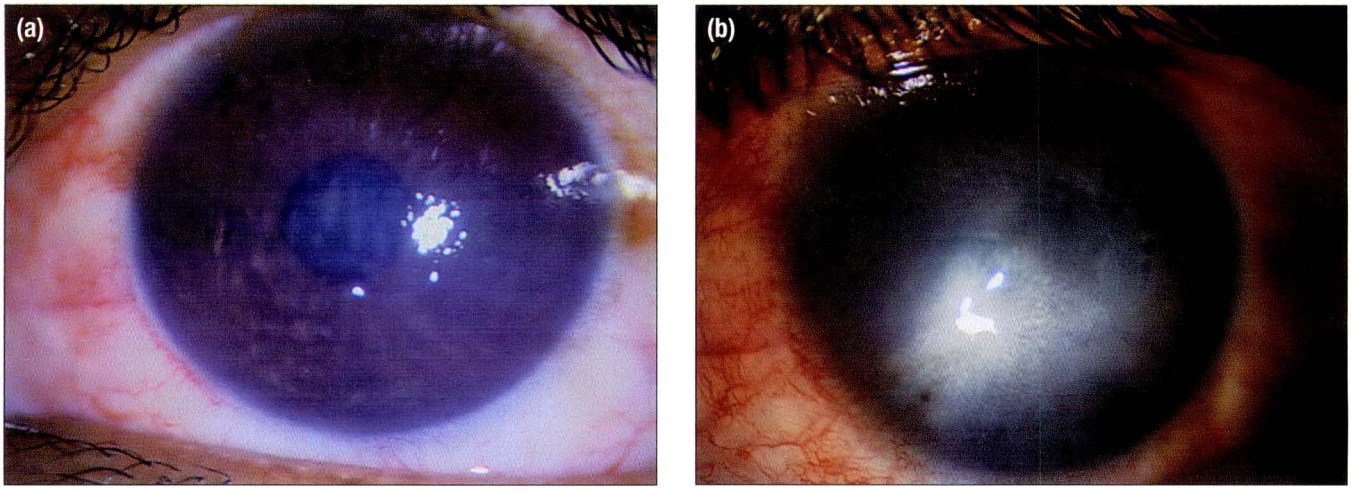
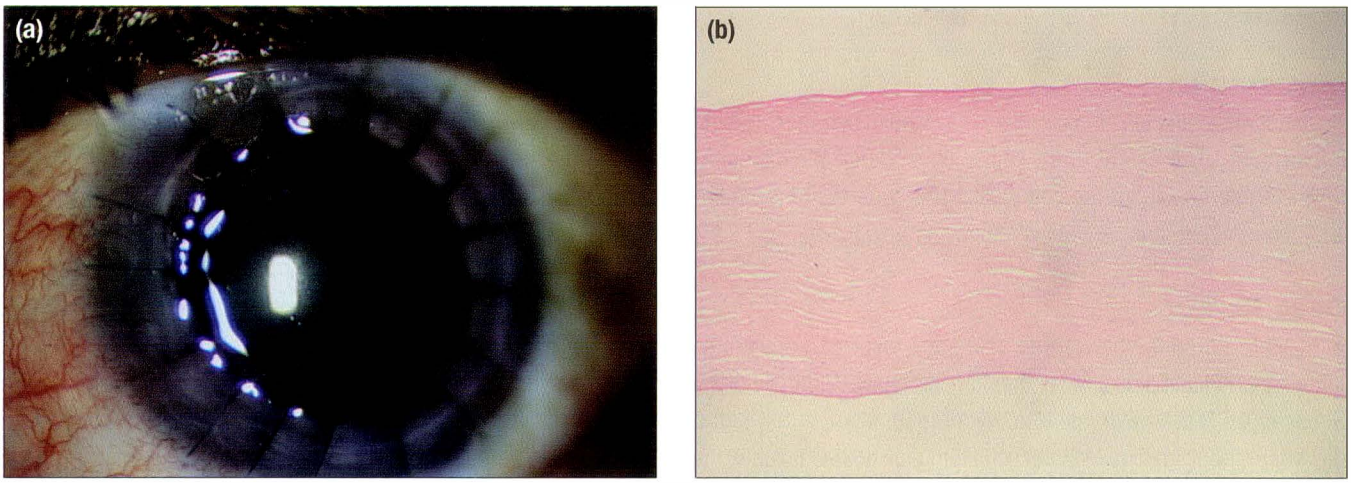


Figure 2. (a) Slit-lamp photograph of the left eye 1 week after penetrating keratoplasty showing a clear graft; and (b) section of the corneal button showing significant reduction of keratocytic nuclei, presence of few inflammatory cells, and absent endothelial cells (haematoxylin and eosin; original magnification, x 10).



thickening) and subsequently endothelial decompensation. Studies in rabbits have shown that hydrochloric acid causes shrinkage of the eye coats, and thereby releases prostaglandins in the anterior chamber.[5] Paterson et al demonstrated reduction of ascorbic acid levels and drop in pH of aqueous after acid burns in rabbit eyes.[6] These biochemical changes are caused by penetration of hydrogen ions into the anterior chamber and may have acted as a deterrent for endothelial function in this patient.

Another interesting feature in this patient was keratocytic cell loss seen on histopathology. Cytokines (especially interleukin 1) released from damaged epithelium are known to induce keratocytic apoptosis.[7] In a study of corneal healing after alkali injuries in rabbit corneas, Chung observed that epithelial healing occurs within 1 week but endothelium goes through a secondary phase of break down that can last for 6 months.[8] Chung et al also studied the effect of dexamethasone on the repair process of corneas affected by alkali injuries.[9] These authors inferred that steroids interfere with the endothelial healing in the initial phase but prevent the secondary breakdown of endothelium.[9] However, it is difficult to directly apply these observations for alkali injury to this patient. Further studies of the pathogenesis of endothelial damage in these situations are required.

The delayed endothelial cell loss and stromal keratocytic loss in the presence of intact epithelium is a unique presentation of a chemical injury. The authors are unaware of any previous similar report in the literature.

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Optical Coherence Tomographic Evaluation of Retained Subretinal Perfluorocarbon

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Perfluorocarbons are tamponading agents used during vitreoretinal surgery. They are toxic to the retina if left inside the eye, and therefore need to be completely removed from the eye. Optical coherence tomography is a non-invasive technique to evaluate the retinal layers that aids the detection of microscopic structural changes in the retinal layers. This report is of the incidental finding of retained subretinal perfluorodecalin in a patient following 3-port pars plana vitrectomy for aphakic retinal detachment in the left eye. The patient had stable visual acuity but showed structural changes in the retina on optical coherence tomogram during follow-up.

Key words: *Fluorescein angiography, Fluorocarbons, Pigment epithelium of eye, Tomography, optical coherence*

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Introduction

Perfluorocarbons are fluorinated hydrocarbons used to stabilise and appose a detached retina during vitreoretinal surgery. However, their toxicity limits their use as a permanent or long-term vitreous substitute.[1-11] This report is of the thinning of the retinal pigment epithelial layer noted on optical coherence tomography (OCT) 6 months postoperatively in a patient who had subretinal retention of perfluorodecalin.

Case Report

A 45-year-old man was referred to the Department of Ophthalmology, Sultan Qaboos University, Muscat, Oman, in 2004 for management of aphakic retinal detachment in his left eye. He had undergone intracapsular cataract extraction in both eyes 15 years earlier. On examination, the best-corrected visual acuity was +13/-1.0/ 45° = 6/6 in his right eye and appreciation of hand movements in his left eye. The intraocular pressure was 12 mm Hg and 10 mm Hg in the right and left eyes, respectively. The cataract wound in the left eye showed vitreous incarceration. Ophthalmoscopy revealed a normal fundus in the right eye. In the left eye, the retina was totally detached with moderate proliferative vitreoretinopathy and multiple tears extending from 4 o'clock to 10 o'clock; there was 1 large equatorial horseshoe tear at 4 o'clock, a group of 3 round holes at 6 o'clock, and a group of 2 round holes at 10 o'clock.

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The patient underwent standard 3-port pars plana vitrectomy with endolaser and silicone oil (5000 cs) endotamponade. Perfluorodecalin was used intraoperatively to flatten the retina, as well as to aid the membrane peeling. The perfluorodecalin was washed out by fluid-air exchange.

The postoperative period was uneventful with a visual recovery in the left eye of 6/60 with +14.0/-5.0/65°. Ophthalmoscopy revealed an attached retina with silicone oil in situ. Follow-up 6 weeks after surgery showed a circular well-defined clear cyst in the foveal area in the left eye (Figure 1), which was confirmed as subretinal perfluorodecalin by the characteristic picture of an oval area of hyperfluorescence surrounded by a hypofluorescent rim on fundus fluorescein angiography (Figure 2). Visual field evaluation

Figure 1. Fundus photograph of a 45-year-old patient with submacular cystic lesion due to retained perfuorodecalin.

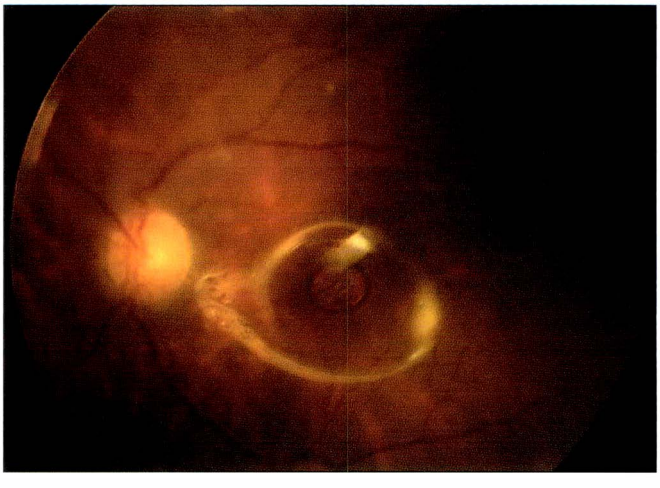


Figure 2. Fundus fluorescein angiogram of the left eye showing an area of hyperfluorescence with hypofluorescent rim characteristic of retained perfluorodecalin.

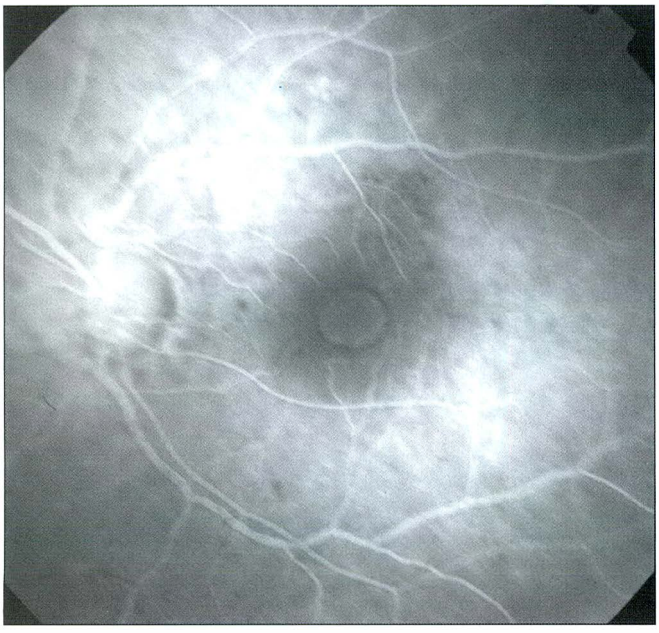


Figure 3. Optical coherence tomography-2 (180° nasal-temporal cut) of the macular area of the left eye showing an oval well-defined area of reduced reflectivity with increased thickness of retinal pigment epithelium/choriocapillary complex inferiorly due to retained perfluorodecalin.

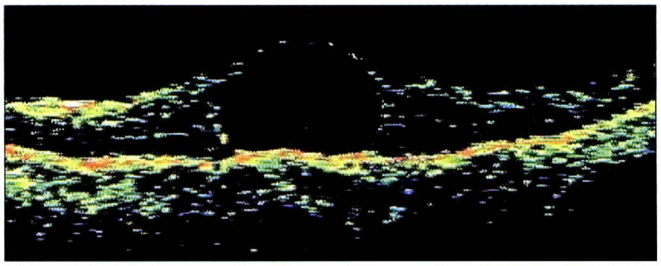
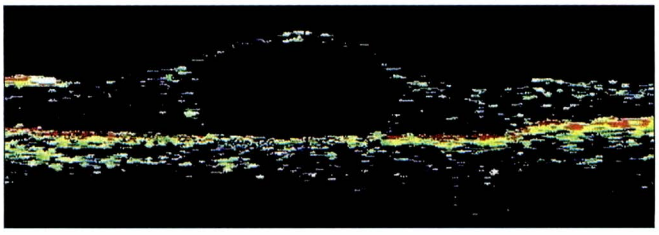


Figure 4. Optical coherence tomography-2 (180° nasal-temporal cut) of the macular area of the left eye showing an increase in width of the cystic mass caused by retained perfluorodecalin with thinning of the retinal pigment epithelium/choriocapillary complex.



using Humphrey automated static threshold perimetry was not conclusive. Serial radial and sagittal sections on OCT 2 showed a well-demarcated circular hyporeflective lesion of the adjacent retina of 315 μm (height) × 450 μm (width) and a normal thickness of 250 μm. The inferior boundary was formed by retinal pigment epithelium and choriocapillaries (Figure 3).

Follow-up 6 months after surgery revealed stable visual acuity with little or no change in the fundus, visual field, and fundus fluorescein angiography in the left eye. However, OCT showed an increase in the width of the cystic mass to 600 μm with the height remaining unchanged. There was thinning of the inferior boundary (Figure 4).

Discussion

Perfluorocarbons are indispensable intraoperative vitreous substitutes for the management of complex retinal detachments.[1-4] Their physical properties determine the tamponading effect and allow easy evaporation during air-fluid exchange. Inadvertent intraocular retention occurs in 3.5% to 6.0% of eyes, causing adverse effects that range from emulsification and development of inflammatory reaction to subretinal migration causing redetachments requiring repeat surgery.[1-11] Large peripheral breaks and/or retinotomies and inadequate saline rinse during air-fluid exchange predispose to retention of perfluorocarbons. However, when outside the macular area, retention of perfluorocarbons has no effect on the anatomical or visual outcome and therefore do not need removal.[6]

Inflammatory reaction secondary to retention was first noted by Eckardt et al[2] and Chang et al[3] in animal eyes. In humans, the age of the patient, the amount of residual vitreous gel, and the amount of retained perfluorocarbon determine the development and severity of inflammation, which resolves with clearing of the media.[4] Dithmar et al detected disturbances in function ranging from minor visual impairment to absolute scotomas using static threshold perimetry with a scanning laser ophthalmoscope in 6 eyes, which improved after surgical removal of the perfluorodecalin.[5]

Lee et al reported atrophy of the retinal pigment epithelium in a patient with giant tear and retained perfluorodecalin.[6] These authors noted an initial media haze, probably due to the emulsification and inflammatory reaction, which explained the structural changes in the retina and the visual loss that occurred later.

The patient in this report underwent pars plana vitrectomy for aphakic retinal detachment and proliferative vitreoretinopathy. The presence of subretinal perfluorodecalin in the macular area was noted postoperatively and was probably due to incomplete removal during air-fluid exchange, followed by its migration through the large equatorial horseshoe tear at 4 o'clock. The diagnosis was confirmed by OCT and by pooling of the dye within the perfluorocarbon bubble shown on fundus fluorescein angiogram. A similar angiographic picture was also reported by Saatci and Kocak[8] and Weidemann et al[7] in a patient who experienced visual loss after 18 months.

An increase in the horizontal diameter of the perfluorocarbon bubble with thinning of the inferior boundary was noted on OCT in this patient at follow-up after 6 months. However, there was no significant change in visual acuity, fundus picture, visual field evaluation, or fundus fluorescein angiogram. Considering the similarity in the angiographic picture and the fact that visual loss occurred 18 months following retention of perfluorodecalin in patients studied by Weidemann et al,[7] the retinal changes on OCT noted for this patient probably herald a functional deficit, indicating a need for its removal.[7-11]

The clinical course and outcome of subretinal accumulation of perfluorocarbons is variable. Their localisation may cause recurrent retinal detachments, and damage to the outer and inner retinal layers.[1-11] OCT is a non-invasive imaging system, which can probably detect changes in the retina due to subretinal retention of perfuorocarbons, and thereby aid in the decision for surgical intervention.[12]

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Burkholderia cepacia: an Unusual Cause of Postoperative Endophthalmitis

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This report is of a 70-year-old man who developed acute postoperative Burkholderia cepacia *endophthalmitis after uneventful extracapsular cataract extraction. Clinical progression of the disease was extremely rapid. Gram staining of the vitreous sample showed gram-negative rods, and the culture was positive for* Burkholderia cepacia. *Intravitreal and systemic antibiotics and pars plana vitrectomy led to resolution of the infection.*

Key words: Burkholderia cepacia, *Endophthalmitis, Therapeutics*

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Introduction

Postoperative infectious endophthalmitis remains a serious complication of intraocular surgery. Microorganisms that colonise the surface structures such as the eyelids, lachrymal sac, and conjunctiva are the usual cause of infection. These organisms include gram-positive aerobic bacteria, gram-negative bacteria, and fungi, and account for 90%, 7%, and 3% of postoperative endophthalmitis, respectively.[1]

Burkholderia cepacia is an increasingly important opportunistic pathogen that is an aerobic gram-negative non-fermentative bacillus widely distributed in the environment, including in water, soil, fruits, and vegetables.[2] *B cepacia* is often found in liquid reservoirs or moist environments, reflecting the organism's innate ability to survive and grow in water sources with minimal nutritional sources.[3] However, the hospital environment remains the primary source of infection.[4] This report describes a patient who developed *B cepacia* endophthalmitis 3 days after extracapsular cataract extraction.

Case Report

A 70-year-old man attended the Department of Ophthalmology, State Hospital, Elazig, Turkey, in 2003 with redness and pain in the left eye for 4 days. The patient had undergone extracapsular cataract extraction and posterior chamber intraocular lens implantation 7 days previously. The patient had no history of ocular trauma and his general health was good. He did not have any features of systemic infection. There were no obvious risk factors for the endophthalmitis such as complications during cataract surgery, surface abnormality, or poor lid hygiene. His visual acuity was 20/20 in the right eye and hand motion in the left eye. He had conjunctival chemosis with intact corneal wound, marked anterior chamber reactions, and very hazy fundal view in the left eye (Figure 1). Ultrasonography demonstrated generalised increases in the echogenicity of the vitreous cavity in the left eye (Figure 2). The right eye was normal.

The patient was treated for acute postoperative endophthalmitis. Emergency vitreal biopsy and intravitreal antibiotic

Figure 1. Conjunctival chemosis, corneal oedema, and marked anterior chamber reaction.

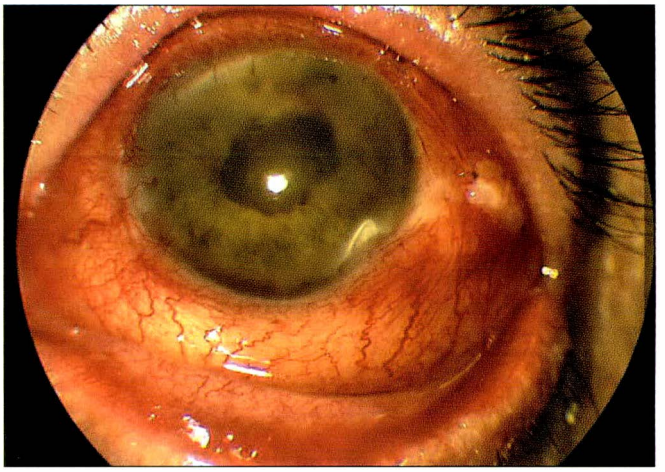

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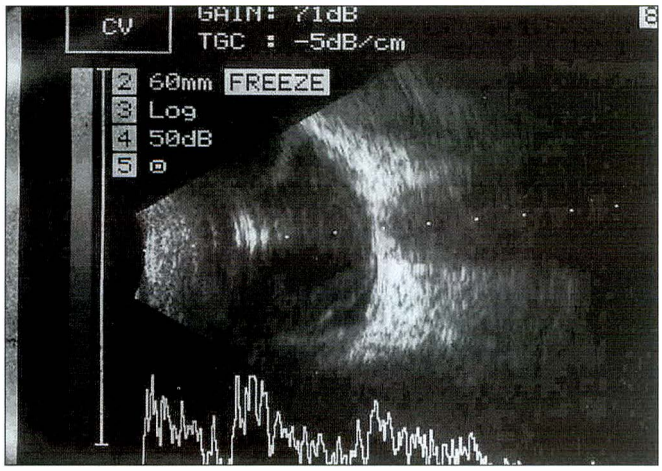
Figure 2. B-scan ultrasound demonstrated a dense cellular infiltrate of the vitreous.



injection (vancomycin 1 mg/0.1 mL and amikacin 0.4 mg/0.1 mL) were performed. Hourly treatment with fortified topical antibiotics, including tobramycin 14 mg/mL and cefuroxime 50 mg/mL, plus prednisolone acetate 1% every 2 hours, and oral ciprofloxacin 750 mg twice daily was started. Gram stain revealed gram-negative rods on the vitreal sample and the biopsy sample was cultured on eosin methylene blue (EMB) medium under aerobic conditions. As the patient's visual acuity was reduced to light perception, pars plana vitrectomy was performed 36 hours after the first injection. The patient's temperature ranged from 38.5°C to 39.2°C after his admission to hospital. At least 3 blood cultures were taken. There was no sign of septicaemia except fever. Gram-negative bacillus grew on the EMB agar at the sample line after 18 to 24 hours of incubation. The bacillus was identified as *B cepacia* by API 20NE system (bioMérieux, Marcy l'Étoile, France). Antibiotic susceptibility test was studied by disc diffusion method and the organism was found to be susceptible to meropenem, imipenem, piperacillin, and sulbactam/cefoperazone, but resistant to ciprofloxacin, amikacin, aztreonam, gentamicin, and ceftazidime. The systemic ciprofloxacin was stopped and meropenem 1 g intravenously 4 times daily was initiated.

Four days after the start of meropenem treatment, the intraocular inflammation improved. Meropenem treatment was continued for 14 days. Subsequently, retinal detachment with an extensive proliferative vitreoretinopathy developed. Two months after the treatment, the eye had light perception vision due to chronic retinal detachment.

To find the possible source of contamination, the patient's post-discharge history was explored, but the patient could not identify any obvious contamination of the ocular wound by external agents. In addition, possible sources of the pathogen such as disinfectant agents, autoclave oven, hospital water system, and operating room were investigated but the source of the infectious agent was not identified.

Discussion

Despite modern techniques and prophylaxis, the incidence of endophthalmitis following cataract surgery ranges from 0.08% to 0.12%.[5] In many patients, the organisms involved are thought to originate from periocularflora. These organisms may gain entry to the eye by means of surgical instruments, irrigation fluid, or contamination of the intraocular lens implant. The most common infecting organisms are *Staphylococcus epidermidis* (38%), *S aureus* (21%) and *Streptococcus* sp (11%). Gram-negative bacilli are present in less than 10% of cases.[5,6]

B cepacia is an unusual non-fermentative gram-negative rod, known primarily as a plant pathogen. *B cepacia* is also well known for its properties of multiple-resistance to antimicrobial agents. It survives on the skin for up to 60 minutes, on a moist surface for up to 1 week, and in water for several years.[7] *B cepacia* rarely causes infection in healthy hosts and usually represents colonisation rather than infection, but it is important when isolated from usually sterile body fluids.[8-10] *B cepacia* causes severe pulmonary infection in patients with cystic fibrosis, and can spread from patient to patient.[11] Other infections caused by *B cepacia* are epidemic conjunctivitis, urinary tract infections (especially where chlorhexidine or benzalkonium chloride have been used as an antiseptic for urologic procedures), heart valve infections, foot lesions, and peritonitis. Contaminated irrigating solutions and disinfectants appear to be associated with many of these infections.[10-13]

B cepacia is a nosocomial pathogen that is well recognised for causing infections associated with contaminated medical equipment and medications.[14] Ritterband et al reported the first case of *B gladioli* keratitis associated with consecutive recurrent endophthalmitis.[15] *B cepacia* is an unusual cause of postoperative endophthalmitis, and, to the best of the authors' knowledge, only 2 culture-confirmed cases have been reported in the literature.[16,17]

Therapy for *B cepacia* infections presents tremendous challenges because of the organism's high-level intrinsic resistance to a wide range of antimicrobial agents. The high level of resistance, the acquired resistance of the organism, and the poor penetration of antibiotics to the eye all conspire to render this intraocular infection extremely difficult to treat. The most effective agents appear to be carbapenems such as meropenem and imipenem and extended-spectrum β-lactamase–resistant agents such as ceftazidime and trimethoprim-sulfamethoxazole.[2,18-20] These antibiotics may be effective as single agents, but there are bacterial isolates for which no single agent is effective in vitro.[18-20]

B cepacia endophthalmitis is difficult to treat. *B cepacia* is most likely to cause a significantly greater number of infections than is currently recognised.[14] This may be related to the inadequacy of current manual and automated systems for identifying *B cepacia*.[9,10,14] Clinicians must be aware of this pathogen, especially when the management of an infection is unsuccessful. Better instrumentation, surgical techniques, prophylactic antibiotics, and understanding of asepsis have significantly reduced the incidence of such infections.

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June 2006

10-14
21st Congress of the Asia-Pacific Academy of Ophthalmology
19th Asia Pacific Association of Cataract & Refractive Surgeons Annual Meeting
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29-1 July
VII International Society of Ocular Trauma Symposium
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16-18
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October 2006

12-13
Centre for Eye Research Australia 10th Anniversary Conference
Melbourne, Australia
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Fax: (61 399) 298 423
E-mail: kmallia@unimelb.edu.au

12-13
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Fax: (41 612) 658 652
E-mail: info@glaucoma-meeting.ch

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11-14
2006 American Academy of Ophthalmology's Joint Meeting with the Asia Pacific Academy of Ophthalmology
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This page is intended to highlight activities of interest to glaucoma specialists and ophthalmologists in Asia. Please let us know of any forthcoming activities that you may be organising or wish to feature on this page.

December 2006

1-3
SEAGIG 2006
Meeting of the South East Asia Glaucoma Interest Group/Asian Oceanian Glaucoma Society and the Glaucoma Society of India
Chennai, India
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Tel: (91 44) 2827 1616
Fax: (91 44) 2825 4180
E-mail: seagig_2006@yahoo.com or drlv@snmail.org

March 2007

28-31
6th International Glaucoma Symposium
Athens, Greece
Contact: Avital Rosen
Tel: (41 229) 080 488
Fax: (41 227) 322 850
E-mail: glaucoma@kenes.com

April 2007

28-2 May
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San Diego, CA, USA
Contact: ASCRS-ASOA, 4000 Legato Road, Suite 850, Fairfax, Virginia 22033
Tel: (1 703) 591 2220
Fax: (1 703) 591 0614
E-mail: ascrs@ascrs.org/asoa@asoa.org

June 2007

9-12
2007 Congress of the European Society of Ophthalmology
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Date: Sunday, June 11, 2006

Time: Scientific program 6:00 PM - 8:00 PM followed by dinner at 8:00 PM

Location: Marina Mandarin Hotel
6 Raffles Boulevard, Marina Square
Singapore 03594

Faculty: G. Chandrasekar, MD; Neil Choplin, MD
Ravi Thomas, MD; Tin Aung, MD

Topics: Case studies and discussion highlighting
- The use of Visante™ OCT for angle assessment
- Stratus OCT™ and GDx™ Scanning Laser Polarimeter for RNFL assessment
- Traditional and new approaches to functional testing, early detection and progression of glaucomatous damage.

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Date: Sunday, June 11, 2006

Time: Scientific program 6:00 PM - 8:00 PM followed by dinner at 8:00 PM

Location: Marina Mandarin Hotel
6 Raffles Boulevard, Marina Square
Singapore 03594

Faculty: Burjor Banaji, MD (Chairperson);
Eckhard Schroeder; Sabong Srivannaboon, MD;
Frank Goes, MD; Swen Lee, MD;
Mona Sabah, MD; Mark Packer, MD (VIDEO);
Ekktet Chansue, MD

Topics:
- Anterior segment evaluation
- MEL 80 clinical trials in USA
- The new CRS Master and combined topography/wavefront guided treatment
- Theory and reality of profile design: TSA, ASA, Presbyopia
- Presbyopia correction with MEL 80: statistical analyses of clinical outcomes
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- Ablation profile (table discussion)

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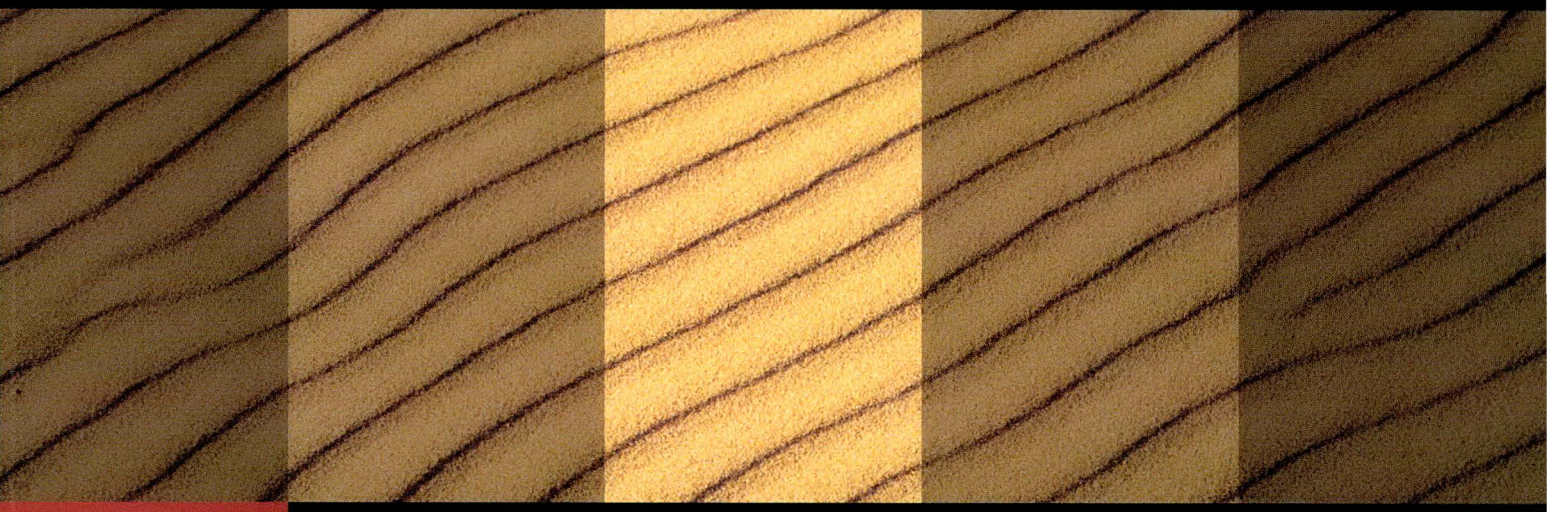

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