EXTRAOCULAR COMPRESSION PRIOR TO CATARACT SURGERY: TIME COURSE OF REDUCTION AND SUBSEQUENT RECOVERY OF INTRAOCULAR PRESSURE

P. H. CONSTABLE and E. J. B. PORTER
London

SUMMARY

This study investigated the rate and degree of reduction in intraocular pressure (IOP) obtained with an external ocular compression device. Following removal of the device, the subsequent recovery in IOP was monitored. We aimed to establish the time course of IOP changes, and thereby to optimise our use of such devices prior to cataract surgery. A rapid initial reduction over the first 10 minutes of compression was followed by a more gradual reduction to a mean reduction of 6.97 mmHg at 40 minutes. Recovery of IOP was rapid and complete by 20 minutes. We conclude that compression of up to 40 minutes duration is beneficial, and suggest such devices should be left on until immediately prior to surgery to preserve the reduction achieved.

The use of external ocular compression devices during peribulbar and retrobulbar anaesthesia to reduce intraocular pressure (IOP) prior to cataract surgery is well established. Prior reduction in pressure is associated with fewer operative complications, notably shallowing of the anterior chamber and vitreous loss.[1] This study aimed to establish the rate and degree of IOP reduction achieved using a Buys mercury bag (Micro-Surgical Technology Inc, USA), and to investigate the subsequent recovery of IOP following removal of the compression.

MATERIALS AND METHODS

Fifteen volunteers ranging in age from 22 to 80 years were used in this ethically approved study. Subjects with a history of previous intraocular surgery, uveitis, glaucoma or hypertension were excluded. Both eyes were used in the study if possible, one eye acting as a control. The eye to be subjected to compression was selected randomly. A total of 15 test eyes and 13 control eyes were used in the study.

The subjects were positioned supine prior to the study commencing, and remained supine and undisturbed throughout the test period. A Buys bag mercury weight was used to provide ocular compression. This is designed to apply a pressure of approximately 30 mmHg evenly to the eye. The device was removed for 30 seconds every 10 minutes during compression to allow the IOP to be measured. Intraocular pressure readings were taken using a Keeler Pulsair 2000 tonometer, a non-contact device which has been found to give an accurate reproducible measurement of the IOP.[2] Measurements were performed every 10 minutes during compression, and every 5 minutes following removal of the device. The compression was applied to the test eye for 50 minutes, and recovery followed over the subsequent 35 minutes. Statistical analysis of the results was performed using Student's *t*-test.

RESULTS

Results are shown in Table I. The mean starting IOP was

Table I. Mean reduction in test eye intraocular pressure (IOP) versus control

	Test eye		Control eye		
Time (min)	Change in IOP from baseline (mmHg)	SD	Change in IOP from baseline (mmHg)	SD	*p* value[a]
0	0	0	0	0	
10	−5.03	2.33	0.04	1.41	<0.001
20	−5.87	2.36	0.38	1.61	<0.001
30	−6.33	2.10	−0.69	1.85	<0.001
40	−6.97	2.16	−0.08	1.48	<0.001
50	−6.83	2.17	0.04	2.03	<0.001
55	−4.93	2.08	−1.08	1.77	<0.001
60	−3.90	2.23	−0.77	2.08	<0.001
65	−2.98	1.85	−1.12	2.62	0.037
70	−1.43	2.21	−0.42	1.71	0.193
75	−0.7	2.68	−1.04	1.52	0.691
80	−0.77	2.85	−0.62	1.73	NS
85	−0.77	2.27	−0.58	1.99	NS

The compression device was applied at $t = 0$ and removed at $t = 50$. Baseline IOP was measured with the subject supine immediately prior to application of the compression device.
[a]Student's *t* -test (test eye vs. control eye).

From: Department of Ophthalmology, Charing Cross Hospital, Fulham Palace Road, London W6 8RF, UK.
Correspondence to: Mr. P. H. Constable, Registrar in Ophthalmology, Department of Ophthalmology, Oldchurch Hospital, Waterloo Road, Romford, Essex RM7 0BE, UK.

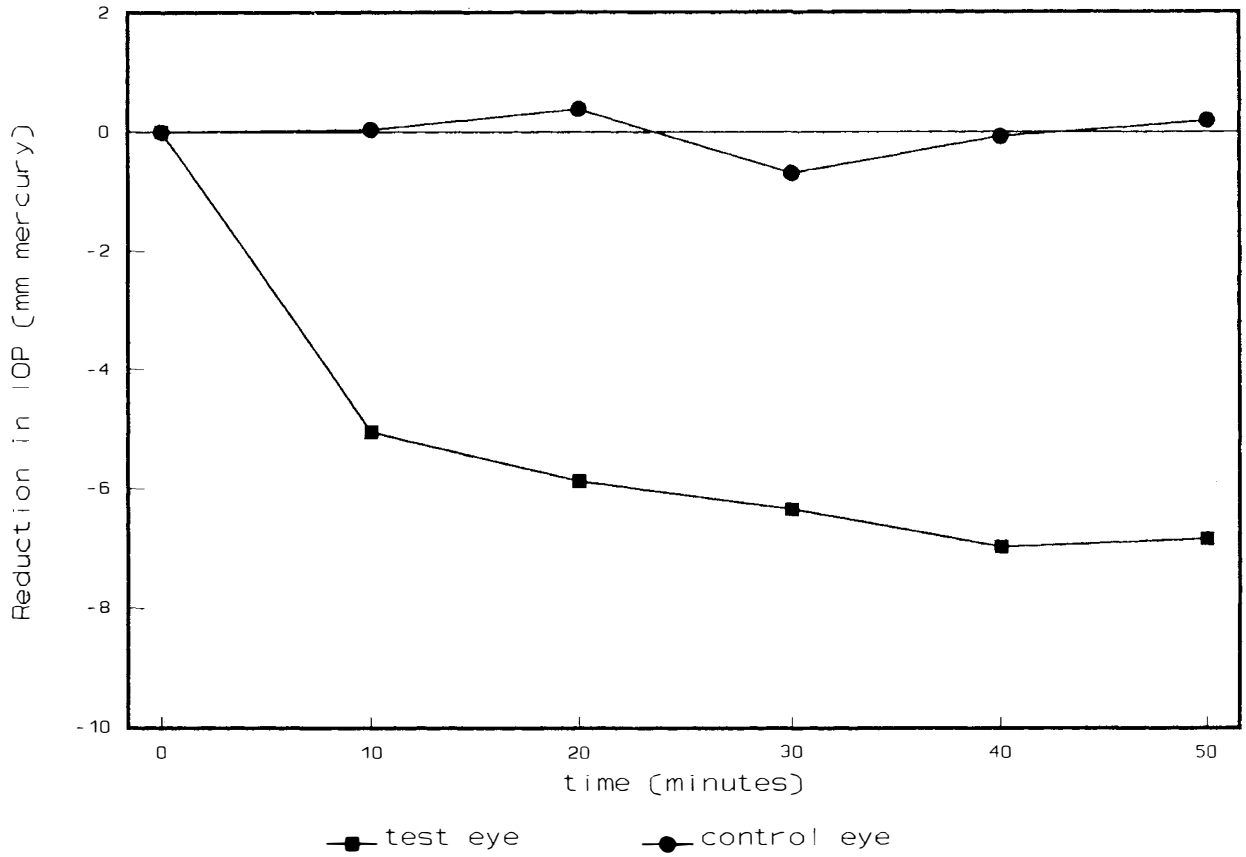

Fig. 1. *Reduction in intraocular pressure with compression.*

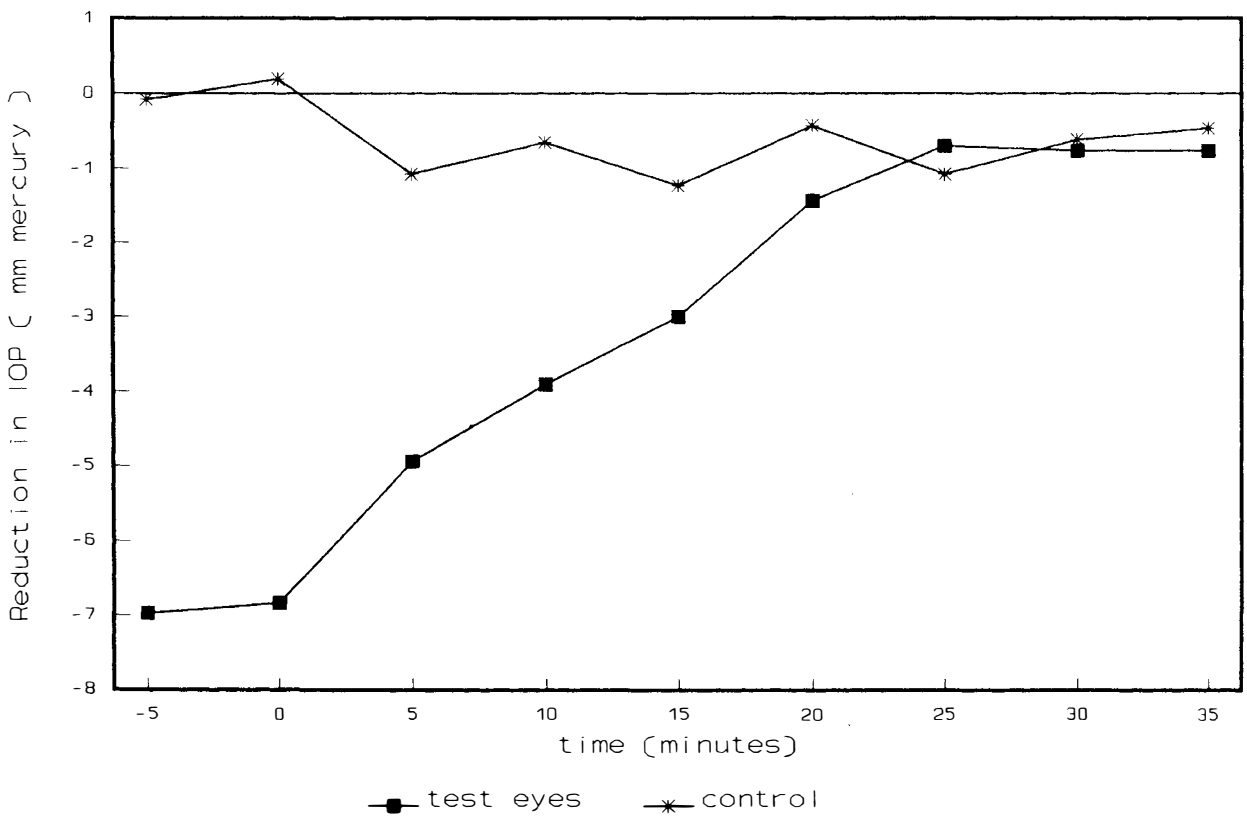

Fig. 2. *Recovery of intraocular pressure after compression removed at* $t = 0$.

15.3 mmHg in the test eyes and 15.2 mmHg in the control eyes. The mean age of the subjects was 47.9 years, with 9 right eyes and 6 left eyes tested. The mean age of the patients in the study is below that of many patients undergoing cataract surgery, but we observed no marked difference in response to compression across the age range studied.

All subjects showed a rapid drop in IOP in the test eyes within the first 10 minutes of compression, with a mean reduction of 5.03 mmHg from the starting IOP ($p<0.001$). Over the remaining test period a reduced rate of decline of IOP was noted up to 40 minutes of compression, with the pressure drop increasing from 5.03 mmHg to 6.97 mmHg ($p<0.001$). No significant change occurred between 40 and 50 minutes of compression ($p = 0.867$). The mean IOP reduction after 50 minutes was 6.83 mmHg (SD 2.17, $p<0.001$). No significant change in the contralateral control eyes was noted over the test period (Fig. 1).

Following removal of the compression device, the IOP immediately started to rise, with no plateau period occurring prior to the recovery. By 20 minutes no significant statistical difference was noted between test and control eyes. No significant overshoot in IOP was recorded in the test eyes (Fig. 2).

DISCUSSION

External ocular compression is extensively used to reduce the IOP prior to intraocular surgery, especially in association with retrobulbar and peribulbar anaesthesia, which cause an initial increase in IOP.[3,4] Digital massage may be used for compression, but more commonly fixed pressure devices containing mercury are employed, such as the Buys bag, which is in routine use at our hospital. The use of compression up to the equivalent of 30 mmHg has been found to be safe,[5] though no previous references to the use of the Buys mercury bag have been found. The results of this study confirm that a significant reduction in IOP is achieved by using such an external compression device on an eye.

The most rapid fall occurs in the first 10 minutes of compression, but the pressure reduction continues for at least 40 minutes. After this period, the IOP seems to plateau, with a mean reduction of 6.97 mmHg achievable. This compares well with IOP reductions of 6.5 mmHg reported with intravenous anaesthetics such as fentanyl used in conjunction with muscle relaxants and ventilation to maintain normocapnoea,[6] and a reduction of 7.5 mmHg with intravenous propofol.[7]

Following removal of the compression device there is no lag period seen prior to recovery of the IOP commencing. The rate of recovery is rapid, with a mean rate of 0.35 mmHg per minute. After 20 minutes there was no significant difference recorded between test eyes and control eyes. No overshoot of IOP was noted – in contrast to the results from some animal studies in which a significant overshoot has been noted.[8]

The reduction in IOP with compression is caused in part by increased aqueous outflow through the trabecular meshwork and other alternative routes such as via episcleral veins and transsclerally, together with reduced ocular blood flow. Mathematical models of aqueous outflow suggest, however, that these changes alone are incapable of fully explaining the degree of pressure reduction seen.[9] Animal models subjected to external ocular compression have demonstrated a reduction in the vitreous volume,[10] and it is likely that a similar process occurs in the human eye, with a reduction in the fluid component of the vitreous.[11] This reduction in the vitreous volume and pressure may be a significant effect of external ocular compression, and could be the most relevant feature in reducing the risk of operative complications.

Following removal of the compression device, the rapid recovery of IOP has been attributed to an increased production of aqueous, together with a rebound rise in the intraocular blood flow.[12] The speed of reversal of the vitreous changes is as yet unknown, but is currently under investigation.

The reduction in IOP using such a compression device is clearly beneficial prior to large-incision extracapsular cataract extractions. The benefit of external compression in small-incision phacoemulsification procedures is less clear, as the tendency for the anterior chamber to collapse is reduced. Low vitreous pressure is, however, still desirable, and external ocular compression has been found to be beneficial in conjunction with regional anaesthesia for phacoemulsification procedures.[13]

The results of this study demonstrate that a significant reduction in IOP can be achieved using an external ocular compression device, and that it is beneficial to apply this for up to 40 minutes to achieve the maximal response. We have also demonstrated that the recovery in IOP is rapid, and complete within 20 minutes, and therefore recommend maintaining compression until immediately prior to surgery to preserve the changes achieved. We found the Keeler Pulsair 2000 tonometer to be a well-tolerated and easy to use instrument, and of use in measuring IOP in cases where contact applanation is difficult.

The authors would like to thank Keeler Ltd. for the loan of their Pulsair 2000 Tonometer for the purposes of this study.

Key words: Cataract surgery, Intraocular pressure, Ocular compression, Pulsair 2000.

REFERENCES

1. Kirsch RE, Steinman W. Digital pressure: an important safeguard in cataract surgery. Arch Ophthalmol 1955;54: 697–703.
2. Moseley M, Thompson JR, *et al*. Comparison of the Keeler Pulsair 2000 non-contact tonometer with Goldmann applanation. Eye 1993;7:127–30.
3. Jay WM, Carter H, Williams B, *et al*. Effect of applying the Honan intraocular pressure reducer before cataract surgery. Am J Ophthalmol 1985;100:523–7.
4. Ropo A, Ruusuvaara P, *et al*. Effect of ocular compression on intraocular pressure in periocular anaesthesia. Acta Ophthalmol 1990;68:227–9.
5. Vorosomarthy D. Oculopression: types and methods of application, possibilities of utilisation. Adv Ophthalmol 1966;17:42–99.

6. Feneck RO, Durkin MA. A comparison between the effects of fentanyl, droperidol with fentanyl, and halothane anaesthesia on intra-ocular pressure in adults. Anaesthesia 1987; 42:266–9.
7. Mirakhur R, Shepherd W. Intraocular pressure changes with propofol (Diprivan): comparison with thiopentone. Postgrad Med J 1985;61 (Suppl 3):41–4.
8. Ostbaum SA, Robbins R, Best M, *et al*. Recovery of intraocular pressure and vitreous weight after ocular compression. Am J Ophthalmol 1971;71:1059–65.
9. Bolling JP, Kurrle RW, O'Day DM. Effect of ocular compression on intraocular pressure. Ophthalmic Surg 1985;16: 563–5.
10. Robbins R, Blumenthal M, Galin M. Reduction of vitreous weight by ocular massage. Am J Ophthalmol 1970;69: 603–7.
11. Palay DA, Stulting RD. The effect of external ocular compression on intraocular pressure following retrobulbar anaesthesia. Ophthalmic Surg 1990;21:503–7.
12. Jay WM, Aziz MZ, Green K. Effect of digital massage on intraocular pressure and ocular and optic nerve blood flow. Acta Ophthalmol 1986;64:58–62.
13. Meyer D, Hamilton RC, *et al*. Effect of combined peribulbar and retrobulbar injection of large volumes of anaesthetic agents on the intraocular pressure. Can J Ophthalmol 1992; 27:230–2.