

Effect of intracameral carbachol on intraocular pressure following clear corneal phacoemulsification

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Abstract

Purpose To investigate the effect of 0.01% carbachol on early intraocular pressure (IOP) after cataract extraction with phacoemulsification.

Methods Fifty-one patients who underwent cataract extraction with phacoemulsification and intraocular lens implantation were prospectively randomly assigned to one of two groups. Twenty-seven patients were given 0.5 ml carbachol intracamerally (carbachol group); the other 24 patients were given the same amount of balanced salt solution intracamerally (control group). IOPs were measured by Goldmann applanation tonometry on the day before surgery, and at 8 h, 24 h and 7 days post-operatively.

Results There was no difference between the mean IOPs of the groups pre-operatively ($p > 0.5$). All the mean post-operative IOP values of the carbachol group were lower than those of the control group. At 8 and 24 h post-operatively the mean IOP was 12.4 ± 3.4 mmHg and 13.1 ± 4.5 mmHg respectively in the carbachol group, 19.4 ± 6.4 mmHg and 17.2 ± 4.2 mmHg respectively in the control group. The differences were significant ($p < 0.04$ and $p < 0.05$). There was no significant difference between the values at 7 days post-operatively ($p > 0.8$). An IOP greater than 25 mmHg was recorded at 8 h and 24 h post-operatively in 8 (33%) and 4 (17%) of the control group and in 1 (4%) and 1 (4%) of the carbachol group. All the IOPs were 20 mmHg or lower in both groups at 7 days post-operatively.

Conclusion Patients treated with intracameral carbachol following uncomplicated clear corneal phacoemulsification and posterior chamber intraocular lens implantation demonstrate lower early post-operative IOP.

Key words Carbachol, Clear corneal incision, Intraocular pressure, Phacoemulsification

Anterior chamber miotic solutions are widely used in cataract surgery. Miosis following implantation of posterior chamber intraocular

lens (IOL) has been shown to aid centration of the IOL, ensure that the pupil is round and does not adhere to capsule fragments or the lens haptics, and prevent incarceration of the iris in the operative wound.^{1,2} Studies have demonstrated that intraocular miotics help control intraocular pressure (IOP) in the early post-operative period.¹⁻⁶

We undertook this study to determine whether carbachol has a pressure-reducing effect following clear corneal phacoemulsification and posterior chamber IOL implantation.

Materials and methods

Fifty-one patients undergoing phacoemulsification and IOL implantation were prospectively randomly assigned to one of two groups. The treatment group ($n = 27$) received 0.5 ml carbachol 0.01% intracamerally and the control group ($n = 24$) received 0.5 ml balanced salt solution (BSS) intracamerally following IOL implantation. In all other respects the patients were treated identically. Patients with previous ocular surgery, glaucoma or IOP more than 21 mmHg were excluded from the study. They had no significant history of eye or systemic disease. The mean age in the treatment group was 54.4 years, and 57.1 years in the control group. There were 16 men and 11 women in the treatment group, 14 men and 10 women in the control group. All surgery was performed using the same pre-, intra- and post-operative procedures in all patients.

Pupil dilatation was accomplished by repeated instillation of phenylephrine 2.5%, tropicamide 1% and cyclopentolate 1%. A retrobulbar block was given. A clear corneal, curvilinear two-plane two-level incision was made in each case. Next the anterior chamber was entered using a 3.2 mm keratome and formed with sodium hyaluronate. Once capsulorhexis had been accomplished hydrodissection was followed by phacoemulsification of the nucleus. After completion of cortex aspiration, the incision was

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Table 1. Mean intraocular pressures in the carbachol and control groups (mmHg \pm SD)

Time of measurement	Carbachol group (n = 27)	Control group (n = 24)	p value
Pre-operatively	16.2 \pm 3.2	15.4 \pm 2.7	0.562
8 h post-operatively	12.4 \pm 3.4	19.4 \pm 6.4	0.039
24 h post-operatively	13.1 \pm 4.5	17.2 \pm 4.2	0.048
7 days post-operatively	14.2 \pm 3.7	14.6 \pm 4.1	0.854

enlarged, the capsular bag expanded by viscoelastic material, and a 5.0 mm, multipiece polymethylmethacrylate posterior chamber IOL was implanted in the capsular bag. In total 0.5 ml sodium hyaluronate was used in all patients during surgery.

Following careful irrigation and aspiration of viscoelastic material from the anterior chamber but also from the capsular bag behind the implanted IOL as described by Wedrich and Menapace,⁶ 0.5 ml carbachol 0.01% or same amount of BSS was injected into the anterior chamber. No intraoperative complication occurred. The wound was closed with a single suture. At the end of surgery, 20 mg gentamicin and 2 mg betamethasone were injected subconjunctivally. Post-operatively the patients were maintained on a tapering dose of prednisolone 1% topically.

IOPs were measured the day before surgery, and at 8 h, 24 h and 7 days post-operatively, by Goldmann applanation tonometry. No topical or systemic antiglaucomatous medication was prescribed during the study period. Statistical analysis was performed using Student's *t*-test. A *p* value of less than 0.05 was determined to be significant.

Results

The mean IOPs were not significantly different between the two groups pre-operatively (*p* > 0.5) (Table 1). However, for each of the post-operative measurements the mean IOP in the carbachol group was lower than the control group mean value. Mean post-operative IOP values in the carbachol group remained below the pre-operative baseline value throughout the study period, whereas only the 7 day mean IOP value in the control group was lower than baseline. The lowest IOP value in the carbachol group was at 8 h (12.4 \pm 3.4 mmHg, mean \pm SD). At the same time the mean IOP of the control group was 19.4 \pm 6.4 mmHg (*p* < 0.04). Twenty-four hours post-operatively the mean IOP of the treatment group was 13.1 \pm 4.5 mmHg, while that in the control group was 17.2 \pm 4.2 mmHg (*p* < 0.05). Mean IOP values in the two groups were similar at 7 days post-operatively (*p* > 0.8).

The mean IOP change was -3.8 ± 4.2 mmHg in the carbachol group and $+4.0 \pm 5.2$ mmHg in the control group at 8 h post-operatively (*p* < 0.001) (Table 2). At 24 h the mean change was -3.1 ± 3.4 mmHg in the treatment group and $+2.2 \pm 3.7$ mmHg in the control group (*p* < 0.001). There was no difference in the mean IOP change between the two groups at 7 days post-operatively (*p* > 0.2).

At 8 h following surgery pressures greater than 21 mmHg were seen in 8 of the 24 patients in the control group; the highest recorded pressure was 29 mmHg. In the carbachol group only 1 patient had a pressure greater than 21 mmHg and the highest recorded pressure was 26 mmHg. Twenty-four hours post-operatively the IOP was still elevated in 4 patients in the control group (maximum 25 mmHg), whereas in the carbachol group only one of the eyes had an IOP of 25 mmHg. All the pressures in both groups were below 21 mmHg at 7 days post-operatively.

Because of severe pain, 4 patients in the control and 9 patients in the carbachol group needed to use an analgesic. No clinically detected increase in post-operative inflammation or hyphaema was noted during the study period.

Discussion

Carbachol (carbaminoylcholine) is a potent synthetic choline ester, differing from acetylcholine by a carbaminoyl group in place of an acetyl group attached to the choline base.² It is primarily a direct-acting agent, with muscarinic and nicotinic effects. It may also cause the release of endogenous acetylcholine from cholinergic nerve fibre terminals or partially inhibit cholinesterase. As carbachol is resistant to hydrolysis by cholinesterase, it is active for much longer than acetylcholine. On a weight-for-weight basis, carbachol is 100 times more potent than acetylcholine. Thus commercial preparations are a 0.01% solution compared with 1.0% for acetylcholine.^{3,7-11} Carbachol has an inhibitory effect on secretion by the ciliary processes.² The intracameral use of carbachol as an alternative to acetylcholine for inducing miosis in association with cataract surgery was described by Reed.¹⁰

Table 2. Mean difference between the pre-operative and post-operative intraocular pressure (mmHg \pm SD)

Time of measurement	Carbachol group (n = 27)	Control group (n = 24)	p value
8 h post-operatively	-3.8 ± 4.2	$+4.0 \pm 5.2$	<0.001
24 h post-operatively	-3.1 ± 3.4	$+2.2 \pm 3.7$	<0.001
7 days post-operatively	-2.0 ± 2.8	-0.8 ± 3.9	0.252

Cataract extraction causes early IOP elevation.^{11–13} IOP reaches its highest point between 6 and 8 h after surgery¹¹ and returns to near-normal levels by 24 h.¹⁴ Although the elevation of IOP following cataract extraction is of short duration and is usually well tolerated by the eye,¹³ even transient elevations may damage the optic nerve fibres, especially in patients with vascular disease or reduced optic nerve head pressure tolerance.¹⁵

In this study, post-operative 8 h and 24 h mean IOP values in the carbachol group were significantly lower than those of the control group. IOP was higher than 21 mmHg in 33.3% of eyes in the control group at 8 h and in 16.6% at 24 h. In the carbachol group, these values were 3.7% and 3.7%, respectively. Hollands *et al.*¹⁶ reported that 82% of patients had pressure greater than 21 mmHg in the control group and 13.6% had pressure greater than 21 mmHg in the carbachol group 6 h following extracapsular lens extraction. Linn *et al.*¹⁷ found equivalent figures of 77% in the control group and 10% in the carbachol group. Wedrich and Menapace¹⁸ reported that 27% of patients in the control group had an IOP of 25 mmHg or more 6 h after scleral tunnel phacoemulsification; they found no patient with such a high IOP in the carbachol group at the same time. Solomon *et al.*¹⁹ reported that all their patients treated with intracameral carbachol following clear corneal phacoemulsification showed a statistically significant reduction in IOP at 6 h post-operatively compared with control group patients.

Within the first 24 h post-operatively, 9 of 27 patients (33%) in the carbachol group complained of a severe brow ache that was controlled with a mild analgesic. Linn *et al.*¹⁷ reported this rate as 42% in the carbachol group within 12 h post-operatively. Hollands *et al.*¹⁶ suggested the use of a lower dose of carbachol for prevention of brow ache after surgery.

The pre-, per- and post-operative management as well as the testing of patients were made as identical as possible in the current study. Because all 51 patients in our study received the same amount of the same viscoelastic, this factor cannot contribute to the differences we found. In addition, the viscoelastic agent was aspirated carefully not only from the anterior chamber but also from the capsular bag behind the IOL just before the injection of carbachol.

Influence of surgical technique on the increase in IOP after cataract surgery has been known.¹³ As it minimises possible trauma to the angle structures because of the small incision used,¹⁸ phacoemulsification causes less IOP elevation than extracapsular cataract extraction.¹³ Mean IOP in the control group was highest at 8 h post-operatively in the control group. It then began to decrease to a mean lower than its pre-operative value and similar to the value in the carbachol group.

In conclusion, carbachol used for intraoperative miosis significantly reduces post-operative IOP increases to a minimum. It can be used safely in clear corneal phacoemulsification surgery with posterior chamber IOL implantation.

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