INTRAOCULAR PRESSURE DYNAMICS AFTER CARBACHOL ADMINISTRATION DURING CATARACT SURGERY

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Abstract

Carbachol is one of the two parasympathomimetic agents currently used during cataract surgery when rapid and complete miosis is needed. Since intraocular pressure (IOP) is one variable modified by cataract surgery, we tried to determine how this variable is further influenced by intracameral administration of carbachol at the end of surgery. The present study concluded that carbachol has a lowering effect on IOP in the first 24 hours after cataract surgery, being responsible for less variations and a more rapid recovery of IOP.

Rezumat

Carbacolul este unul dintre cei doi agenți parasimpatomimetici folosiți actualmente în timpul operației de cataractă, atunci când este necesară o mioză rapidă și cât mai completă. Întrucât tensiunea intraoculară (IOP) reprezintă o variabilă modificabilă prin operația de cataractă, am încercat să determinăm în ce măsură această variabilă este influențată în plus de administrarea intracamerală de carbacol la finalul intervenției chirurgicale. Prezentul studiu concluzionează că injectarea carbacolului are un efect de scădere a tensiunii intraoculare în primele 24 de ore postoperator, acesta determinând mai puține variații și o mai rapidă redresare a tensiunii intraoculare.

Keywords: Carbachol, Cataract Surgery, Intraocular Pressure.

Introduction

During cataract surgery, miosis may be needed and may be very helpful in several circumstances. For instance, it is useful in case of complications as capsular tear or zonular dehiscence, to protect the vitreous face, to avoid iris incarceration in the wound, to facilitate anterior chamber intraocular lens (IOL) insertion or 3-piece-IOL suturing to the iris. At the end of cataract surgery, miotics injection in the anterior chamber is especially useful to center the artificial lens and to prevent pupillary capture of the posterior chamber- IOL [1].

Currently, two parasympathomimetic agents are available for intraocular use in order to obtain rapid and complete miosis during intraocular surgery: acetylcholine chloride and carbachol. The first one has a direct action on the iris sphincter muscle, but being rapidly metabolised by acetylcholinesterase it has a short half-life. Carbachol has both a direct and indirect effect on iris sphincter and a longer half-life, since it is not transformed by acetylcolinesterase [1]. Its onset of action varies between two to five minutes and its duration of action is 4 to 8 hours when topically administered and 24 hours after intraocular administration [4].

Carbachol is preconditioned as a 0.01% solution in a balanced salt solution (BSS) vehicle for intraocular injection; the active principle has the chemical structure displayed in Figure 1.

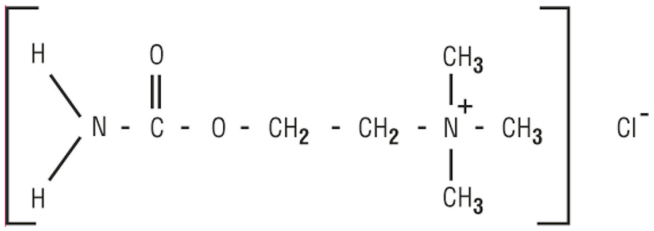

Figure 1
Carbachol chemical structure

Materials and Methods

Our study included 64 patients recruited from the University Hospital and Clinic Ophthalmology Hospital, Bucharest, Romania. The study protocol was approved by The Ethical Committee of University Hospital and Clinic Ophthalmology Hospital, Bucharest, Romania. A written informed consent was obtained from each study participant.

In the present study we aimed to assess the effect of phacoemulsification and intracameral carbachol injection on intraocular pressure.

The present study was designed as a prospective, non-randomized, cohort study. A total of 64 patients with cataract who were scheduled for phacoemulsification were included. The patients were randomly assigned to two groups. At the end of the surgery the first group received 0.4 mL of 0.01% carbachol intracamerally, while the second group (control group) received 0.4 mL of balanced salt solution in the anterior chamber. All

patients had uneventful cataract surgery and all interventions were performed by the same surgeon between 2012-2013.

To be included in the study all the patients had to have a diagnosis of cataract. The exclusion criteria were represented by: previous ocular surgery, uveitis, glaucoma, ocular hypertension or other ocular conditions preventing reliable Goldmann tonometry.

When quantifying the postoperative decrease in IOP, it is very important to clearly document baseline IOP determined preoperatively. We considered as baseline IOP, the value estimated preoperatively with the following algorithm: the estimation was done using at least two values measured in the last month before surgery and if the difference between measurements was less than 2 mmHg, the time interval between the valid measurements was at least 5 days.

The patients were admitted to the hospital one day before surgery. On the following day, during the morning, standard phacoemulsification procedure with intraocular lens implantation was performed. After surgery, Goldmann tonometry was performed at 3, 6, 21 and 24 hours.

The software used for data analysis was SPSS version 18. Means were compared using t test. A *p* value less than 0.05 was considered statistically significant.

Results and Discussion

The study comprised 64 patients divided in two groups. In the first group of 32 patients, all patients were administered 0.4 mL of 0.01% carbachol. The control group consisting of other 32 patients did not received postoperative carbachol intracameral injection, but an injection with the same volume of vehicle: BSS (balanced salt solution).

Study group characteristics are shown in Table I.

Table I

Study group characteristics

	Carbachol group	Control group
Age, mean (years)	71.7+/-8.27	73.14+/-6,6
Female (%)	67	52
Preoperative IOP, mean (mmHg)	15.18+/-1.79	15.25+/-2.08
3 hours postop IOP	19.62+/-3.76	19.58+/-2.87
6 hours postop IOP	18.48+/-4.12	20.25+/-2.33
21 hours postop IOP	16.02+/-3.18	17.6+/-2.94
24 hours postop IOP	15.43+/-2.47	17.15+/-3.77
Operating time (min)	18.42+/-4.13	19.01+/-3.62
Viscoelastic use	+	+

Phacoemulsification induced, as expected, a statistically significant decrease in IOP, noticed in both groups (p=0.019 and p=0.0006 in control and carbachol group respectively).

At 3 hours postoperatively, IOP was statistically significant higher in both groups, but at 6 hours in carbachol group IOP slightly decreased while in control group, IOP reached the highest value (20.25+/-2.33 mmHg). At 21 and 24 hours the IOP was statistically higher than baseline only in the control group ($p < 0.05$). 24 hours IOP in control group was statistically significant higher than in carbachol group (p=0.04), despite the fact that baseline IOP in both groups were similar (Figure 2).

IOP values in control group remained significantly higher than baseline at all-time points.

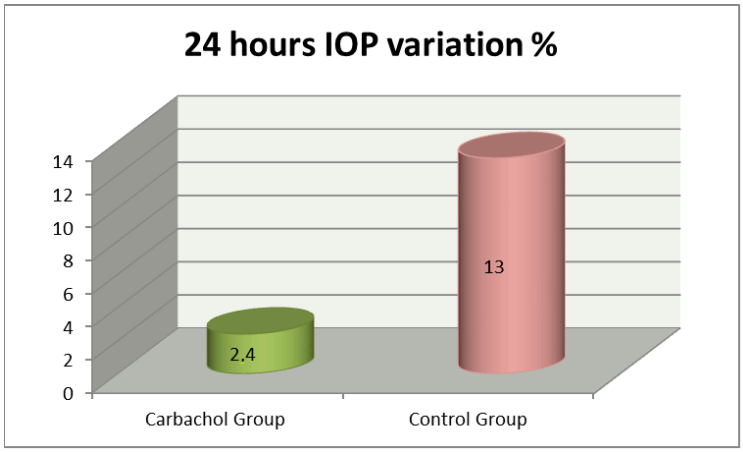

Figure 2
24 hours IOP variation from baseline displayed in percentage

Gormaz (1962) was the first reporting an acute transient increase in intraocular pressure after uneventful phacoemulsification [3]. These changes are represented by transient elevations of IOP [4-7]. In addition, carbachol has a lowering effect on intraocular pressure (IOP), which may be beneficial in the first 24 hours after cataract surgery; this effect is particularly important for glaucoma patients, in which strict control of postoperative IOP is needed [8].

Studies [1] comparing carbachol to acetylcholine chloride have found carbachol to be a better pharmacological agent for controlling intraocular pressure 20 to 24 hours postoperatively. The sphincter pupillae muscle is innervated by postganglionic parasympathetic nerve fibers originating in ciliary ganglion, which constricts when stimulated. These

fibers innervate also the ciliary muscle and induce accommodation, facilitating the aquous humor outflow as well. The neurohumoral transmitter involved is acetylcholine [9]. IOP decrease after intraocular use of acetylcholine seems to be determined by the increase outflow of aqueous humor through the trabecular meshwork [10]. A possible inhibitory effect on aqueous humor secretion might be involved as well [11].

Carbachol, a synthetic choline ester, differs from acetylcholine structure only by having a carbamoyl group (NH_2CO^-) instead of an acetyl group (CH_3CO^-) attached to the choline base. Due to the fact that carbachol is resistant to hydrolysis by cholinesterase, its action lasts much longer comparing to acethylcholine.

In our study, the mean preoperative IOPs were similar in both groups. The difference consisted in that the highest IOP values were reached at different times in carbachol (3 hours postoperatively) and in control (6 hours postoperatively) groups.

We also recorded IOP variation in the first 24 hours after surgery and in carbachol group, this variation was smaller than in control group. The difference between 24 hours IOP and preoperative IOP was significantly higher in control group (24 hours IOP higher with 13% than preoperative IOP) compared to carbachol group (24 hours IOP higher with 2.4% than preoperative IOP). Our findings are consistent with other studies [12, 13, 14].

However, beside the IOP lowering effect, the use of intracameral carbachol may have an important disadvantage, namely the exacerbation of postoperative inflammation, which is supposed to be due to delayed restitution of the blood-aqueous barrier [8, 15]. Another matter of concern is the possibility of endothelial toxicity of carbachol with intracameral administration. "*In vitro*" studies on human cornea [1] demonstrated no ultrastructural damage to the corneal endothelium, but still a certain degree of reversible corneal swelling may be caused by carbachol intraocular injection [1].

Conclusions

The present study found that in the first hours after uneventful phacoemulsification IOP significantly increased, but the injection of 0.4 mL 0.01% carbachol in the anterior chamber at the end of the surgery determined less variations and more rapid IOP recovery. Intracameral carbachol administration after clear corneal phacoemulsification and posterior chamber intraocular lens implantation results in lower early postoperative IOP values.

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