

Corneal Endothelial Cell Density and Morphology Following Bolus versus Infusion Intracameral Adrenaline during Phacoemulsification

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Purpose: To compare early postoperative corneal endothelial cell density and morphology after phacoemulsification using bolus versus infusion intracameral adrenaline.

Methods: In this randomized clinical trial, 71 eyes of 71 patients scheduled for phacoemulsification were randomly assigned to two groups: one group (31 eyes) received bolus intracameral adrenaline (1:10,000) and the other group (30 eyes) received adrenaline infusion (1:1,000,000). Pre- and one month postoperatively, a complete ophthalmologic examination as well as endothelial evaluation using ConfoScan III was performed; effective phaco time (EPT) and mydriasis during surgery were also compared between the study groups.

Results: The two study groups were not significantly different in terms of demographic characteristics, lens opacity and EPT. Endothelial cell density was 2737 ± 321 cell/mm² in the bolus group vs 2742 ± 426 cell/mm² in the infusion group preoperatively (P=0.1). One month postoperatively, the rate of cell loss was 7.21% in the infusion group versus 8.87% in the bolus group (P= 0.13). Pupil diameter was >6 mm in 48% of eyes in the infusion group vs 33% of eyes in the bolus group (P=0.5).

Conclusion: Adrenaline was safe at the studied concentrations and there was no significant difference between bolus and infusion routes of administration in terms of pupil dilation and endothelial cell loss.

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INTRODUCTION

Regardless of surgical technique, adequate mydriasis is essential for all stages of cataract surgery. Pupil contraction during phacoemulsification or the irrigation/aspiration phase increases the chances of iris damage, incomplete cortical material removal, posterior

capsule rupture, vitreous loss and difficulty with intraocular lens (IOL) implantation into the capsular bag.¹ Although the preoperative use of mydriatic agents including anticholinergics and sympathomimetics can often achieve adequate mydriasis early during surgery, other mydriatic agents are often required to maintain pupillary dilation during the procedure.¹⁻³

Intracameral adrenaline has been used as a potent mydriatic agent since long ago and has been reported to be harmless to the corneal endothelium even in high concentrations (1:1000) provided that it is free of bisulfite.⁴⁻⁶ There is evidence that high concentrations of adrenaline may not be necessary; 1:400,000 seems to be as effective as 1:25,000 dilution³ and 1:1,000,000 dilution can be used via continuous infusion during surgery for maintaining mydriasis and decreasing the chance of preservative related corneal endothelial cell damage.¹ Adrenaline with bisulfite preservative is still used in our country and no study has compared corneal endothelial cell changes with bisulfite preserved and preservative free adrenaline. Corneal endothelial cell damage is the most common cause of corneal edema⁷; the current study was conducted to evaluate corneal endothelial cell changes using bisulfite preserved adrenaline at different concentrations and with different modes of administration during phacoemulsification.

METHODS

Seventy-one eyes of 71 patients scheduled for cataract surgery at Al-Zahra Hospital, Zahedan, Iran were enrolled in a randomized clinical trial. All eligible subjects were provided with explanation of the study design and purposes and were enrolled into the study after obtaining informed consent. Inclusion criteria were age between 40 to 70 years and nuclear opacity of grade IV or less according to LOCS (lens opacities classification system) III. Diabetic patients and those with previous intraocular surgery or with concomitant ocular conditions such as uveitis, glaucoma, corneal pathology or clinical signs of pseudoexfoliation syndrome as well as subjects with pupil diameter less than 5 mm after administration of mydriatic drops at the onset of surgery were excluded. We also excluded cases of vitreous loss.

Preoperative examinations included visual acuity, tonometry, funduscopy, keratometry, refraction and lens opacity grading according

to LOCS III. All eyes underwent confocal scanning one day before and one month after surgery using ConfoScan III device. Patients were randomly divided into bolus and infusion groups. All eyes received one drop of diclofenac-Na 1% (Voltaren 1%), once one hour preoperatively and one drop of tropicamide 1% (Mydriaticum 1%), three times at 5 minute intervals prior to surgery.

Statistical analysis was performed using SPSS (version 11) and Stata (version 6) softwares. Independent sample and paired *t*-tests were used for comparing mean values between and within the two groups respectively with significance level set at 0.05.

Surgical Technique

All patients underwent scleral tunnel phacoemulsification by the same surgeon under peribulbar anesthesia. After preparing and draping the eye, a wire lid speculum was inserted and the fornices were irrigated with Ringer solution. Peritomy was performed in the superotemporal (right eyes) or superonasal (left eyes) quadrants and bleeding vessels were occluded using bipolar cautery. A 3.5 mm frown incision was made in the sclera posterior to the surgical limbus and a scleral tunnel was then created using a crescent knife reaching clear cornea. A stab incision was made in clear cornea 50-70 degree away from the main incision using a 15° knife.

Thereafter, the bolus group received a 0.5 ml intracameral injection of 1:10,000 adrenaline prepared by adding 1ml of a 1mg/ml adrenaline ampoule (Daroupakhsh Co., Tehran, Iran) to 9ml BSS (balanced salt solution). The infusion group received adrenaline infusion at 1:1,000,000 concentration intraoperatively which was prepared by adding 0.5 ml from the same ampoule to 500 ml of BSS. The anterior chamber was then formed using methylcellulose 2% (Coatel, Opsia Co., France) and capsulorrhexis was performed with a bent 27-gauge needle. Nucleus emulsification was performed (Protégé, Storz) using the divide and conquer technique. Residual cortical material

was then manually removed with a double-cannula needle. A foldable hydrophilic acrylic IOL (Akreos, Bausch & Lomb) was inserted into the capsule bag using a holder. After washing out viscoelastic material from the anterior chamber, all eyes received a 0.2 ml injection of acetylcholine through one of the surgical incisions. Wound sealing was performed using a single suture at the site of the main incision, if needed.

At the conclusion of surgery, subconjunctival injections of 100mg cefazolin, 40mg gentamicin and 4mg betamethasone were given and the eye was patched. Betamethasone (every 2 hours) and ciprofloxacin (every 4 hours) eye drops were started on the day after surgery. Ciprofloxacin drops were discontinued after one week and betamethasone drops were tapered and discontinued over five weeks.

RESULTS

The study included 36 eyes of 36 patients including 19 female and 16 male subjects with mean age of 63.3±9.5 in the bolus group and 35 eyes of 35 patients including 21 female and 15 male subjects with mean age of 64.0±6.2 years in the infusion group. There was no significant difference between the two groups regarding age and sex. The two groups were not significantly different in terms of lens nucleus color (NS) and opacity (NO) according to LOCS III scores; mean NO values were 2.11 vs 2.39 (P=0.13) and mean NC values were 1.91 vs 2.19 (P=0.07) in the bolus vs infusion groups, respectively.

Mean dilated pupil diameter at the onset of surgery was 6.98±0.58 mm in the bolus group vs 6.9±0.61 mm in the infusion group (P=0.45). Mean effective phaco time was 33.2±22.1 and 29.7±22.6 seconds in the bolus and infusion groups, respectively (P=0.5). The capsule was stained with trypan blue in five eyes including four eyes in the bolus group and one eye in the infusion group. Mean volume of intra-operative fluids was 175 vs 186 ml of BSS in the bolus vs infusion groups respectively (P=0.39). Pupil diameter >6 mm at the time of IOL insertion was achieved in 48% vs 33% of eyes in the bolus vs infusion groups, respectively (P=0.268).

Overall, mean preoperative endothelial cell count was 2740±375 (range 1146-3080) cell/mm² and mean preoperative endothelial cell pleomorphism was 62.23±4.35%. Mean pre- and postoperative endothelial polymegethism values were 31.33%±5.78% and 33.04%±4.81%, respectively. Table 1 summarizes endothelial cell characteristics based on confocal scanning in the study groups preoperatively and one month postoperatively. Mean endothelial cell loss was 8.87±4.62% vs 7.21±4.49% in the bolus vs infusion group, respectively (P=0.13). Changes in endothelial cell pleomorphism and polymegethism did not significantly differ between the two groups.

Mean uncorrected visual acuity was 0.43±0.18 vs 0.39±0.13 LogMAR in the bolus vs infusion group, respectively (P=0.24). Corresponding values for best-corrected visual acuity were 0.69±0.22 vs 0.69±0.17 LogMAR respectively (P=0.6).

Table 1 Corneal endothelial cell status pre- and one month postoperatively

Endothelial cell status		Mean ± standard deviation		P value
		Bolus group	Infusion group	
Count (cell/mm ²)	Pre-op	2737±321	2743±426	0.1
	Post-op	2498±348	2547±435	0.6
Polymegethism (%)	Pre-op	29.38±5.08	31.33±5.78	0.13
	Post-op	31.41±4.06	33.04±4.81	0.12
Pleomorphism (%)	Pre-op	62.78±5.47	62.23±4.35	0.8
	Post-op	62.67±4.13	62.06±4.02	0.53

Pre-op, preoperatively; Post-op, postoperatively

DISCUSSION

Phacoemulsification is the popular and preferred technique of cataract surgery.^{8,9} In the present study we evaluated the effect of bisulfite preserved adrenaline on corneal endothelial cells with bolus or infusion routes of intracameral administration. Mean corneal endothelial cell density has been reported to be 2400 (range 1500-3500) cells/mm² in normal adults.⁹ The corresponding preoperative value in the present study was 2740±375 (range 1146-3080) cells/mm². The higher endothelial cell density in our series may be due to exclusion of subjects older than 70 years. Mean corneal cell density in our patients is similar to that of normal Filipinos (2798±307 cells/mm²).¹⁰

Polymegethism, the coefficient of variability of cell size, is normally less than 30% and values greater than 40% are associated with a greater chance of corneal decompensation.⁹ Mean endothelial cell polymegethism was 31.33%±5.78% preoperatively and 33.04%±4.81% postoperatively in our patients; both values were within normal limits.

It is believed that intraocular surgery may lead to corneal decompensation in the presence of pleomorphism greater than 50%.⁹ However, in the present study despite a mean preoperative endothelial cell pleomorphism of 62.23%±4.35%, no eyes developed chronic corneal edema. We cannot explain this discrepancy.

Different rates of corneal endothelial cell loss following cataract surgery have been reported which depend on the surgeon, technique of surgery, type and volume of infusion fluid and phacoemulsification machine and duration.¹¹⁻¹³ The highest rate of endothelial cell loss with newer methods of cataract surgery has been reported by Pirazzoli et al¹⁴ using the phacofracture technique (13.8%±4.3%) and the lowest has been reported by Kiss et al¹¹ following phaco chop technique (8.5%±0.3%). Corresponding values in our patients were 7.21%±0.74% in the infusion group and 8.78%±0.87% in the bolus group.

The adrenaline preparation used in most of the above-mentioned studies was bisulfite-free.

This buffering agent is thought to be toxic to corneal endothelial cells.⁵ Although we used bisulfite preserved adrenaline, changes in endothelial cell characteristics were not significantly different from other studies.

In conclusion, it seems that bolus and infusion administration of bisulfite preserved adrenaline during phacoemulsification achieve comparable levels of mydriasis and do not significantly differ in terms of corneal endothelial cell count and morphology.

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