Comparison of corneal endothelial cell count and intraocular pressure in pure-dispersive and dispersive-cohesive viscoelastic protection in phacoemulsification surgery

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ABSTRACT

There are so many aspects should be regarded when use viscoelastic device during phacoemulsification surgery. The advantages and disadvantages of pure-dispersive viscoelastic and dispersive-cohesive viscoelastic always require more our attention to use it conveniently. The purpose of the study was to compare between pure-dispersive viscoelastic versus dispersive-cohesive viscoelastic in phacoemulsification surgery in that of corneal endothelial cell count and intraocular pressure (IOP) change. This was a cross-sectional study involving 41 eligible patients who underwent phacoemulsification surgery by single operator. Data including characteristics of cataract patients, corneal endothelial cell count and IOP were taken before and after surgery. Data of characteristics of cataract patients were reported descriptively and compared using Anova and t-test. The mean change in corneal endothelial cell count on pure-dispersive viscoelastic group (71.99±71.20 cells/mm²) was lower than that on the dispersive-cohesive viscoelastic group (117.62±78.29 cells/mm²). However, it was not significantly different. The mean change in IOP on pure-dispersive viscoelastic group (0.75±1.626 mmHg) was significantly lower than that on dispersive-cohesive viscoelastic group (1.90±0.995 mmHg) (p=0.000). In conclusion, the increase of IOP in dispersive-cohesive viscoelastic group is higher than that on pure-dispersive viscoelastic group. However, there is no significant difference of the mean change in corneal endothelial cell on the both groups.

ABSTRAK

Banyak aspek yang harus diperhatikan ketika menggunakan peralatan viskoelastis selama tindakan bedah fakoemulsifikasi. Kelebihan dan kekurangan viskoelastis murni dispersif dan viskoelastis dispersif kohesif selalu memerlukan perhatian agar dapat digunakan dengan nyaman. Penelitian ini bertujuan untuk membandingkan viskoelastis murni dispersive dengan viskoelastis dispersif kohesif pada tindakan bedah fakoemulsifikasi dengan membandingkan perubahan jumlah sel endotel kornea dan tekanan intraokuler. Penelitian ini merupakan penelitian potong lintang yang melibatkan 41 pasien yang menjalani tindakan bedah fakoemulsifikasi yang memenuhi syarat oleh operator tunggal. Data yag meliputi karakteristik pasien katarak, jumlah sel endotel kornea dan tekanan intraokuler diambil sebelum dan sesudah pembedahan. Data demografi dilaporkan secara diskriptif dan dibandingkan dengan Anava dan uji t. Rerata perubahan jumlah sel endotel kornea pada kelompok viskoelastis murni dispersif (71,99±71,20 sel/mm²) lebih rendah daripada kelompok viskoelastis dispersif kohesif (117,62±78,29 sel/mm²), namun tidak berbeda nyata (p>0,05). Rerata perubahan tekanan intraoculer pada kelompok viskoelastis murni dispersif (0,75±1,626 mmHg) lebih rendah secara nyata daripada kelompok viskoelastis dispersif kohesif (1,90±0,995 mmHg) (p<0,05). Dapat disimpulkan, kenaikan tekanan intraokuler pada kelompok viskoelastis dispersif kohesif lebih tinggi daripada kelompok

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viskoelastis munri dispersif. Namun demikian, tidak terdapat perbedaan nyata rerata perubahan jumlah sel endotel kornea pada kedua kelompok.

Keywords: phacoemulsification - corneal endothelial cell - intraocular pressure – visco-elastic – pure-dispersive - dispersive-cohesive

INTRODUCTION

Age related cataract is believed to be the main cause of reversible blindness worldwide especially in developing countries.[1] It is estimated that blindness due to cataract is increasing by 1-2 million annually.[2] About 20 million individuals suffer from blindness due to cataracts[3] and 80% of them live in the developing countries.[4]

One of the most known treatment for cataract is phacoemulsification surgery. Phacoemulsification is safer, has faster rehabilitation, as well as less astigmatism and better postoperative vision compared to conventional extra capsular cataract extraction (ECCE).[5] It has largely replaced manual nucleus extraction (MNE) as the procedure of choice for cataract surgery.[6] However, there is an important factor in phacoemulsification procedure that needs to be considered when performing cataract surgery; the effect of viscoelastic, or also known as ophthalmic viscosurgical device (OVD) on the corneal endothelium.

There are two types of OVDs i.e. cohesive OVDs and dispersive OVDs. Both are used for different occasions. For example, a cohesive OVD could be selected to expand a small pupil, while a dispersive OVD could be used to protect an eye with a compromised corneal endothelium.[7] Eventhough some surgical strategies use two OVD types together in layers or serially,[8] the ability to protect endothelium and avoidance of intraocular pressure (IOP) spikes are the important factors that need to be considered in selecting an OVD.

The endothelium-protecting efficacy of an OVD can be evaluated in terms of postoperative measurements of endothelial cell density. The loss of endothelial cell during surgery or the postoperative phase can deteriorate at a faster-than-normal rate for at least 10 years thereafter.[9] If the normal endothelial cell density of ~2400 cells/mm2 falls below 300–500 cells/mm2, corneal edema can develop, and can be followed by bullous keratopathy.[10] Rheological properties indicate that a dispersive OVD, with its propensity to coat and protect intraocular tissues, might be a better choice for endothelial protection.

While we need OVDs capability to completely coat and protect intraocular tissues during surgery, an ideal OVD should also be able to be completely removed from intraocular tissues at the end of surgery. Residual OVD left in the eye can clog the trabecular meshwork, leading to a transient elevation in postoperative IOP.[11-13] This ocular hypertension sometimes need to be treated with IOP reducing medication, such as prophylactically in response to postoperative observations of IOP spikes to ≥30 mmHg[14] or ≥35 mmHg.[15] To avoid this complication, surgeons need to select an OVD that is conducive to complete removal. Rheological properties indicate that a cohesive OVD, with its propensity to be removed as a bolus, might be better than a dispersive OVD for avoiding IOP spikes.

The considerations of choosing the best OVDs sometimes work at cross purposes; no single OVD is a clear choice. The purpose of this study was to compare pure-dispersive viscoelastic and cohesive-dispersive viscoelastic in phacoemulsification surgery in term of corneal endothelial cell count and intraocular pressure change.

MATERIALS AND METHODS

Subjects

This was a cross-sectional study involving 40 eligible patients who underwent phacoemulsification surgery by single operator at the Department of Ophthalmology, Dr. Sardjito General Hospital, Yogyakarta. Data including characteristics of cataract patients, corneal endothelial cell count and intraocular pressure were taken before and after surgery. Corneal endothelial cell count was determined using specular microscope and intraocular pressure was determined using non-contact tonometer. The study has been approved by the Medical and Health Research Ethics Committee, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta.

Procedures

All the patients eligible to participate had to give inform consent and fill the questionnaire then followed by eye examination including visual acuity, anterior segment examination using slit-lamp, specular microscope and tonometry. Phacoemulsification surgery was performed by single operator. Measurements were performed two times i.e. before and after surgery.

Statistical analysis

Characteristics data of patients were reported descriptively. Proportion data was determined using Chi-square test. Comparison of corneal endothelial cell count and IOP change was calculated using Anova and t-test. All data analyses were performed with a commercial statistical software package (SPSS 16.0 for windows)

RESULT

A total of 41 (20 with pure-dispersive viscoelastic, 21 with cohesive-dispersive viscoelastic) patients were examined. The characteristics data of patients showed that both of two groups were similar in that of age, sex, grade of cataract, pre-op-corneal endothelial cell count but not in pre-op-intraocular pressure (TABLE 1.)

TABLE 1. Characteristics of subjects

Variable	Pure-dispersive viscoelastic (n= 20)	Cohesive-dispersive viscoelastic (n= 21)	p
Age (mean ± SD year)	61.05±13.7	64.76±12.9	0.378
Sex [n (%)]			
• Male	9 (45)	12 (57.1)	0.437
• Female	11 (55)	9 (42.9)	
Grade [n (%)]			
• 2	11 (55)	5 (23.8)	0.272
• 3	7 (35)	10 (47.6)	
• 4	2 (10)	6 (28.6)	
Endothelial count (mean ± SD cells/mm^2)	2961.05±178.21	2942.38± 133.00	0.705
IOP (mean ± SD mmHg)	17.40±1.93	15.61±1.68	0.003

IOP: intraocular pressure

TABLE 2 revealed that the mean change in corneal endothelial cell count on pure-dispersive viscoelastic group was 71.99±71.2 cells/mm^2, whereas that in the cohesive-dispersive viscoelastic group was 117.62±78.29 cells/mm^2. No significantly difference in the change of corneal endothelial of both groups was observed (p=0.056). The mean change in IOP on pure-dispersive viscoelastic group was 0.75±1.626 mmHg, whereas that in cohesive-dispersive viscoelastic group was 1.90±0.995 mmHg. Significantly difference in the change of IOP of both groups was observed (p=0.000).

TABLE 2. Change in that of corneal endothelial cell count and IOP pre- and post phacoemulsification surgery in both groups

Variable	Pure-dispersive viscoelastic (n= 20	Cohesive-dispersive viscoelastic (n= 21)	p*
Endothelial cell count			
(mean ± SD cells/mm²)			
• Pre-	2961.05± 178.21	2942.38± 133.00	0.056
• Post-	2889.80±204.23	2824.80±165.60	
Change	71.99±71.2	117.62±78.29	
IOP (mean ± SD mmHg)			
• Pre-	17.40±1.93	15.61±1.68	0.000
• Post-	18.15±1.83	17.51±1.70	
Change	0.75±1.626	1.90±0.995	

IOP: intraocular pressure; *Anova

Change in that of corneal endothelial cell count and IOP in each group are presented in FIGURE 1 and FIGURE 2.

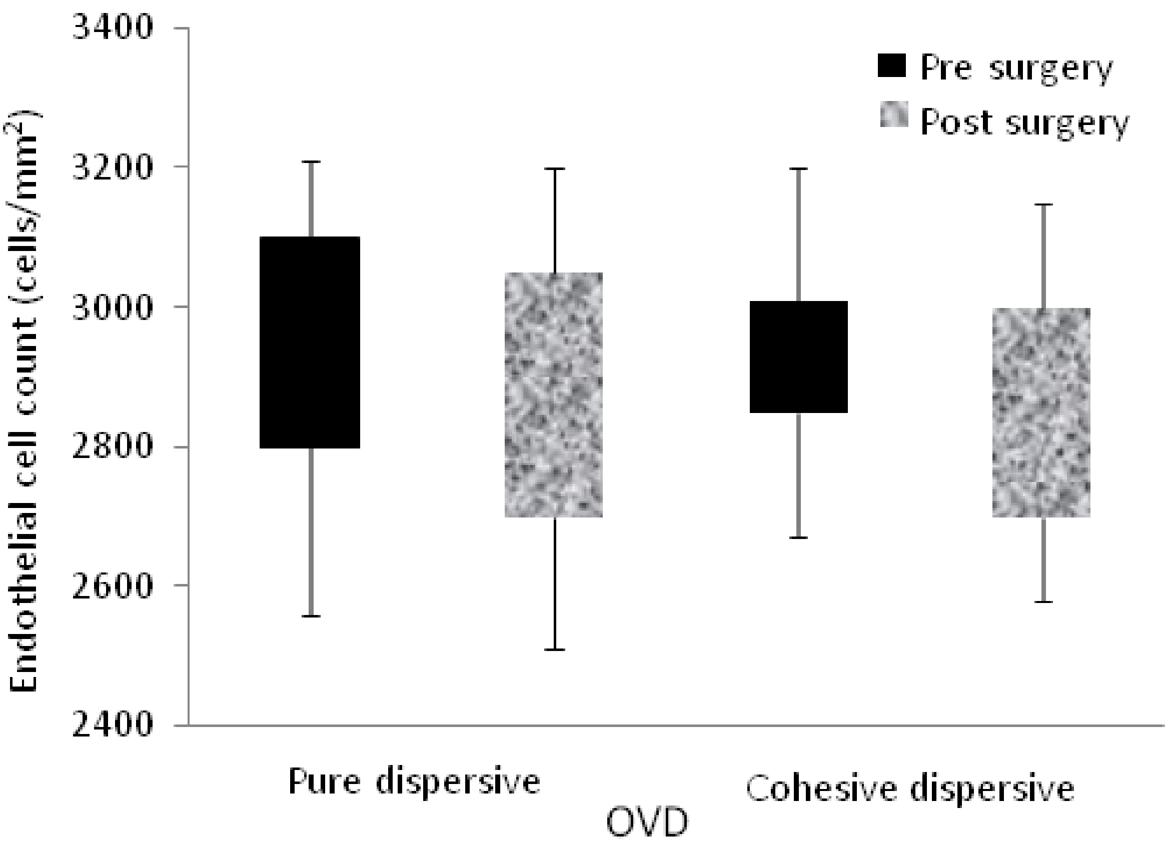

FIGURE 1. Change in the endothelial cells count pre- and post- phacoemulsification surgery in both groups

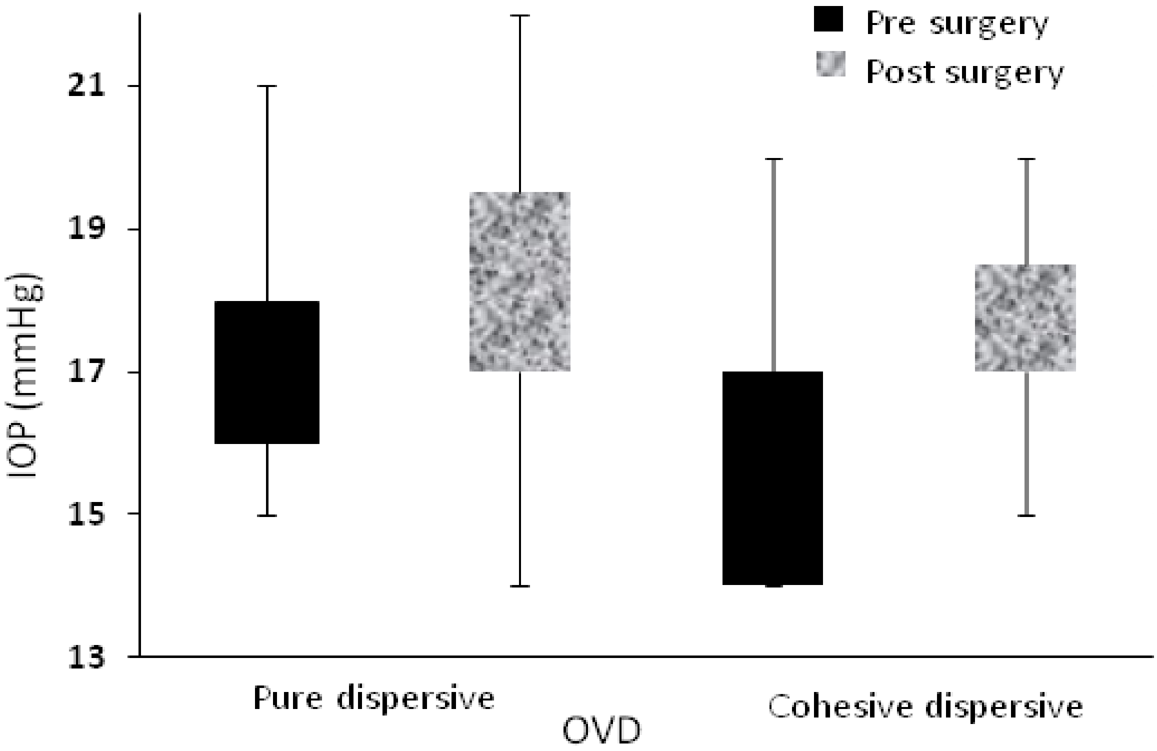

FIGURE 2. Change in the IOP pre- and post phacoemulsification surgery in both groups

DISCUSSION

OVDs facilitate cataract surgery by maintaining the depth and shape of the anterior chamber. This provides a workspace for the surgeon and viscous barrier that protects the delicate corneal endothelium from surgical instruments, from cataractous lens debris, and the intraocular lens during insertion.[7] Early OVDs were classified as either cohesive or dispersive, on the basis of objective rheological properties.[16] Cohesive OVDs are useful in creating and maintaining space in the anterior chamber.[7] Because cohesive OVDs tend to hold together as a mass, they are relatively easy to remove as a bolus at the end of surgery.[7] In contrast to cohesive OVDs, dispersive OVDs spread out when injected into the eye, making these substances less effective for maintaining space but more effective for coating and protecting intraocular tissues.[17] Irrigation/aspiration tends to pull away bits and fragments of dispersive OVDs, making these materials more difficult to remove at the end of surgery.[7,17] The different properties of cohesive and dispersive viscoelastics broaden the opportunities for a surgeon's selection of an OVD for cataract surgery.

The rheological properties of any OVD arise from the monomer type and polymer formulation of its constituents. In some cases, these constituents provide not only physical protection, but also chemical protection. Cohesive-dispersive viscoelastic contains two biologically relevant glycosaminoglycans: 1.6% hyaluronic acid (also found in connective tissues) and 4% chondroitin sulfate (also found in cartilage). Both chondroitin sulfate and hyaluronic acid are antioxidants. During an in vitro simulation of phacoemulsification, an OVD containing 3% chondroitin sulfate and 4% hyaluronic acid suppressed free radicals significantly more than an OVD containing 2.3% hyaluronic acid alone. The relative chemical and rheological protective effects of various OVDs are not yet fully understood.

With regard to the protection of endothelial cells in the current study, the percentage cell loss with the pure-dispersive viscoelastic group was lower than that with the cohesive-dispersive group although it was not significantly different. It is not clear whether the endothelial protection provided by the OVDs was due to rheological properties, to chemical /antioxidant content, or to a combination of both. Protection could be related to endothelium-coating properties of the OVDs. Modi *et al*.[18] reported their two studies using animal eyes that a thin uniform layer of DisCoVisc OVD remained as a lining on the inner cornea after phacoemulsification and removal of OVD. It was suggested that this coating was indicative of the protective effects of the DisCoVisc OVD.

Rainer *et al*.[19] revealed the mechanism of postoperative IOP increase was not yet fully understood. A major reason for the postoperative IOP increased seems to be the amount of the remaining viscoelastic agent at the end of surgery. It was assumed that the remaining viscoelastic agent mechanically obstructs the trabecular outflow pathway and hence decreases the outflow facility. In order to avoid a postoperative IOP increase, a thorough removal of viscoelastic agent is vital. Surgical techniques for the removal of viscoelastic substances, especially from behind the IOL, have been described, but a complete prevention of a postoperative IOP increase could not be achieved with any technique.

Both of two types of viscoelastic must be removed out completely. However, it was nearly impossible to completely remove both viscoelastic agents without injuring the endothelium and other vulnerable structures of the eye. Assuming that the amounts of the remaining viscoelastic substances were similar in our study, the difference in postoperative IOP increase between the two viscoelastic agents might be explained by differences in their biophysical properties. The clearance of the viscoelastic agent through the trabecular meshwork is believed to be dependent upon the viscosity and molecular weight of the used materials. Theoretically, the lower the viscosity and the molecular weight of the viscoelastic agent, the faster is the clearance through the trabecular meshwork. In accordance with this theory, in our study “dispersive” which is less viscous and has a lower molecular weight than “cohesive” caused less IOP increasing. The lower viscosity of “dispersive” compared with “cohesive” may, however, have the disadvantage of poorer endothelial cell protection.

CONCLUSION

This study revealed that the increase of IOP in cohesive-dispersive viscoelastic group is higher than that in pure-dispersive viscoelastic group. However, the change in corneal endothelial cells is similar in both groups.

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