THE INFLUENCE OF VISCOELASTIC SUBSTANCES ON THE CORNEAL ENDOTHELIUM DURING CATARACT SURGERY BY PHACOEMULSIFICATION

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SUMMARY:
PURPOSE: To compare the ability of different ophthalmic viscoelastic devices to protect the corneal endothelium following in-the-bag phacoemulsification with posterior chamber intraocular lens (IOL) implantation.
MATERIAL&METHODS: We studied 50 patients with soft to moderately dense (Grade 1-3) cataract and corneal endothelial cell density of >2000cells/mm². The corneal response to surgery was evaluated by measuring the endothelial cell loss, the variation in the mean cell area of the endothelial cells (CV), and the central corneal thickness, all that by using a TOPCON SP 2000P noncontact, specular microscope. Data were recorded preoperatively and postoperatively.
RESULTS: Preoperatively, no statistical significant difference was observed in cell count, CV, or pachymetry among groups. Postoperatively, all the groups had a statistically significant decrease (p<0,001) in endothelial cell count. There was an equal and significant (p<0,001) increase in visual acuity. Between groups there was no statistically significant difference (p>0,17) in any of the parameters we studied.
CONCLUSIONS: Between the OVDs we used, either DisCoVisc or ProVisc&VisCoat, there was no statistical significant difference neither in surgical outcome nor in endothelial layer aspect and function. DisCoVisc protected better the endothelium cells even if it was not statistically significant, and is the one that can be used for the entire surgical procedure.

Key Words: endothelial cells; ophthalmic viscoelastic device; specular microscopy.

INFLUENȚĂ SUBSTANȚELOR VÂSCOELASTICE PE ENDOTELIUL CORNEEAN ÎN CHIRURGIA CATARACTEI PRIN FAICOEMULSIFICARE

REZUMAT.
OBJECTIV: Studiul a avut ca scop compararea abilității diferitelor substanțe vâscoelastice oftalmice (OVD) de a proteja endotelul corneean în timpul facoemulsificării urmate de implantarea de pseudofak de camere posterioră (IOL). MATERIAL&METODĂ: Studiul a cuprins 50 pacienți cu cataractă (gradul 1-3) și cu densitate celulară endotelială corneeană > 2000 celule/mm². Pacienții au fost împărtăși în două grupuri, în funcție de vâscoelasticul folosit (Provisc&Viscoat/DisCoVisc). Răspunsul corneean la trauma chirurgicală a fost evaluat măsurând densitatea de celule endoteliale corneene (CD), coeficientul de variație al ariei celular endoteliale (CV) și grosimea centrală a corneei pre și postoperator. Măsurătorile au fost făcute cu un microscop specular noncontact TOPCON SP2000P.
REZULTATE: Preoperator nu au fost găsite diferențe semnificative statistice între pacienții studiați în ceea ce privește CD, CV sau pachimetria. Postoperator toți pacienții au suferit o pierdere celulară semnificativă statistică (p<0,001) și o creștere semnificativă în acuitate vizuală (p<0,001). Postoperator nu au fost găsite diferențe semnificative statistice între grupuri. CONCLUZII: Între vâscoelasticle folosite (Provisc&Viscoat/DisCoVisc) nu au existat diferențe semnificative din punct de vedere al rezultatului postoperator și nici din prismă aspectului sau a funcției endotelului corneean. Toate aceste date duc la concluzia că DisCoVisc-ul este vâscoelasticul care conferă o bună protecție a endotelului și o bună vizualizare pe tot parcursul operației de facoemulsificare.

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INTRODUCTION

Using an ophthalmic viscosurgical device (OVD), commonly called viscoelastic, during intraocular surgery is the standard of care in anterior segment surgery. Viscoelastics have been classified into two categories: COHESIVE and DISPERSIVE. Ophthalmic surgeons are aware of qualitative differences in the physical behavior of single component, *hyaluronic acid* - based Viscoelastics (= cohesive) and a *chondroitin sulfate/hyaluronic acid* mixture (= dispersive) during intraocular surgery. Whether to use a cohesive or dispersive OVD always depends on the phase of the surgical procedure and on the surgeon preferences.

Cohesive Viscoelastics provide good anterior chamber maintenance and they tend to hold together.

Dispersive Viscoelastics coat and protect intraocular tissues (especially endothelium)

MATERIALS & METHODS

Our study involved 50 patients - 31 females and 19 males with soft to moderately dense (Grade 1-3) cataract and corneal endothelial cell density of > 2100/mm². All cases underwent cataract surgery using phacoemulsification with intraocular lens (IOL) implantation at the Clinic of Ophthalmology, Timisoara. Patients were between 18 and 87 years old (fig.1).

We divided the 50 cataract patients (54 eyes) into 3 groups, according to the type of OVD that was used:

- ProVisc and Viscoat - 38 eyes
- DisCoVisc - 15 eyes
- Celoftal - 1 eye

We used foldable implants (AcrySof-27, AcrySof Natural-7 and AcriSof IQ-18, AcrySof multipiece-2) (figure 2)

The corneal response to surgery was evaluated by measuring the endothelial cell loss, the variation in mean cell area of the endothelial cells (CV), the frequency of hexagonal cells, and the central corneal thickness using a TOPCON SP 2000P noncontact specular microscope. Specular microscopy was performed pre and postoperatively in the central area. On the first postoperative day the eyes were evaluated for corneal oedema and Descemet's folds.

I present three cases to exemplify some of the changes that may occur in the corneal endothelium after cataract surgery.

P. E. (F) 62 years. The patient was operated for glaucoma 5 years ago and we performed phacoemulsification and foldable IOL implantation in the

In all cases we used some OVD:

- ProVisc — high molecular weight (COHESIVE) = Sodium Hyaluronate
- Viscoat — medium molecular weight (DISPERSIVE) = Sodium Hyaluronate(3,0%) Sodium Chondroitin Sulphate(4,0%)
- DisCoVisc — (VISCOUS DISPERSIVE) = Sodium Hyaluronate(1,65%) Sodium Chondroitin Sulphate(4,0%)
- Celoftal - methylcellulose

![Fig.1. Age repartition in this study group](image-url)
Postoperatively we noticed the increase of:
- central corneal thickness (from 513 µm to 568 µm) indicating a swelling of the cornea,
- maximum cell area (from 620 µm² to 907 µm²) the large cells could be the result of spreading to fill defects but could also represent the coalescence of cells,
- average cell area (from 373 µm² to 497 µm²),
- coefficient of cell area variation (CV) (from 28 to 40) indicating endothelial polymegathism.

The striking fact was a significant decrease in endothelial cell count (from 2674 cells/mm² to 2012 cells/mm²) as a sign of endothelial trauma caused by cataract surgery.

**S.B. (F) 61 years** he had no associated corneal pathology, but we can identify a certain variation in the endothelial cells hexagonal pattern and area. We performed phacoemulsification with foldable IOL implantation in the right eye. Phacoemulsification time was 0, 2 (min/6) and power 8%. OVD: Viscoat and ProVisc.

Postoperatively we evaluated the same parameters. We noticed the difference between pre and post operative image. We can easily observe the polymorphism (the hexagonal pattern is no longer respected) and polymegathism of the endothelial cells (significant increase in standard variation- SD- and CV).

**V.M. (F) 41 years.** Preoperatively he has no associated corneal pathology and has a great hexagonal pattern and a very good endothelial cell density. We performed phacoemulsification and foldable IOL (AcrySof IQ) implantation in the right eye. Phacoemulsification time was 0, 2 (min/6) and power 3%. OVD: DisCoVisc.

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![Figure 2. Foldable lenses used in the study](image)

![Figure 3. P. E. (F) 62 years - preoperative](image)

![Figure 4. P.E. 16 days postoperative](image)

![Figure 5. S.B. (F) 61 years – Preoperative](image)

![Figure 6. S.B. - 14 days postoperative](image)
Postoperatively, even though the cell density decreased, there were no significant changes in the other parameters. The regular hexagonal pattern was respected, suggesting that the endothelial layer preserved all its functions.

**RESULTS**

Preoperatively, no significant difference was observed in cell count, neither in CV, hexagonal pattern or pachymetry among groups. In two cases we could not perform speculometry postoperative (patients did not return for checkup).

Postoperatively, in all cases we found statistically significant changes (p< 0.02) in all studied parameters(table 1).

The visual acuity increased extremely significant (p<0.001) and so did the corneal thickness. Corneal thickness increased from 533,51µ ± 37.2µ (preoperative) to 554,17µ ± 36.5µ (postoperative-less than 2 months)

The maximum and average cell area significantly increased from a statistic point of view (p<0.0001). Endothelial cells are known to have the capacity to shift,

Table1. Correlation between pre and post operative values of specular microscopy

<table>
<thead>
<tr>
<th></th>
<th>Nr. cases</th>
<th>Min</th>
<th>Max</th>
<th>Avg</th>
<th>Mediana</th>
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<td>52</td>
<td>0</td>
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<td>0.1</td>
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<td>1</td>
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<td>608</td>
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<td>549.5</td>
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<td>366</td>
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<td>962</td>
<td>402</td>
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<td>CV pre op</td>
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<td>16</td>
<td>49</td>
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<td>30.28</td>
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elongate, expand and rearrange after a minimal endothelial trauma.\textsuperscript{1,2,3}

Postoperatively all three groups had a significant decrease in endothelial cell count. The decrease was smaller in the DisCoVisc group (11.2\%) and in the ProVisc and Viscoat group (16.5\%), than in the one we used Celoftal (21.03\%).

Thickness returns to preoperative levels after two to three months, as reported in other studies.\textsuperscript{4,5}

Changes in the coefficient of variation or hexagonality were observed postoperatively within the three groups, suggesting a certain level of polymegathism and pleomorphism.

**DISCUSSIONS**

Every cataract surgery, no matter how carefully performed, induces some endothelial loss due to mechanical trauma.

It looks like dispersive OVD offers better protection to the endothelium,\textsuperscript{6,7,8,9} one by coating this corneal layer and by its ability to remain longer in the anterior chamber, despite the irrigation/aspiration flow during phacoemulsification. Cohesive tend to adhere to themselves when one part leaves the eye and reforms outside the eye. Because they stick together, they are easier to remove. Unlike cohesive, dispersive tend to be difficult to remove from the eye because they adhere to tissues and structures, and this adherence is very helpful in protecting the endothelium.

Corneal thickness increases after surgery because water passes the endothelium due to surgical trauma. But the fact that the corneal thickness returns to normal after two or three months\textsuperscript{4} shows that the endothelium recovers and is functioning well.

Even if the endothelial pump function is preserved, the endothelial cell population suffers some changes. Some cells are lost after surgical trauma and the ones nearby are rearranging in order to fill the gaps. This leads to an increase in average endothelial cell area (polymegathism) and changes the regular hexagonal cell pattern (pleomorphism).

We noticed no statistical significant difference between the endothelial cell loss in the group where we used DisCoVisc and the one we used ProVisc&VisCoat. Even so, the percents showing the endothelial cell loss were lower in the DisCoVisc group – 11.96\% compared to 17.66\% in ProVisc&VisCoat group (figure 11).

DisCoVisc is suitable for all surgical procedures that require viscoelastic most of all because it exhibits both cohesive and dispersive properties but also because he provides good visualization during surgery, is easy to inject, offers good protection to intraocular structures and still is easy to remove at the end of surgery.

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**Figure 10.** Corneal thickness

**Figure 11.** Correlation between endothelial cell loss (%) and OVD used
CONCLUSIONS

OVDs are coating the endothelium and help in maintaining a deep anterior chamber during intraocular surgery, reducing the endothelial cell loss.

Between the OVDs we used, either DisCoVisc or ProVisc&VisCoat, there was no statistical significant difference neither in surgical outcome nor in endothelial layer aspect and function.

DisCoVisc protected better the endothelium cells, even if it was not statistically significant and is the viscoelastic that can be used for the entire surgical procedure.

REFERENCES