Comparison of BD Multivisc™ with the soft shell technique in cases with hard lens nucleus and Fuchs endothelial dystrophy

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PURPOSE. *To compare the efficacy of 2.5% sodium hyaluronate (BD Multivisc™) with the soft shell technique in reducing corneal endothelial cell damage during cataract phacoemulsification in patients with hard lens nucleus (3+) and cornea guttata.*
METHODS. *Thirty patients (37 eyes) scheduled for cataract surgery at Department of Ophthalmology and Visual Sciences, University Hospital San Raffaele, Milano, Italy. Thirty-seven eyes (randomly divided into Groups A and B) with hard lens nucleus (grade 3 or higher) and cornea guttata had phacoemulsification using the soft shell technique (Group A) with Biolon® (sodium hyaluronate 1%) and Viscoat® (sodium hyaluronate 3%–chondroitin sulfate 4%) or with BD Multivisc™ alone (Group B). Patients were evaluated preoperatively and after 1, 15, 90, and 180 days, checked for best-corrected visual acuity (BCVA), intraocular pressure (IOP), central corneal thickness, and corneal endothelial density. Stop and chop phacoemulsification technique, with burst mode (Alcon Legacy 20000, Advantec), was performed.*
RESULTS. *There were no significant differences between the two groups at 3 and 6 months in BCVA, IOP, corneal thickness, or endothelial cell density. The increase of central corneal thickness (preoperative: Group A 584±30 µm, Group B 573±30 µm; postoperative at 90 days: Group A 593±38 µm, Group B 577±25 µm) was not significant. Endothelial cell loss was similar in both groups.*
CONCLUSIONS. *The results suggest that the soft shell technique (Biolon®, Viscoat®) and 2.5% sodium hyaluronate (BD Multivisc™) are both effective in protecting the corneal endothelium in Fuchs dystrophy during phacoemulsification in patients with hard lens nucleus. (Eur J Ophthalmol 2007; 17: 709-13)*

KEY WORDS. *2.5% sodium hyaluronate, BD MultiviscTM, Soft shell technique, Cataract phacoemulsification, Hard lens nucleus, Cornea guttata*

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INTRODUCTION

Modern methods of phacoemulsification and high-density viscoelastic substances have minimized the corneal endothelium cell loss and the incidence of bullous keratopathy after cataract surgery. The incidence of bullous keratopathy, however, is still elevated among patients presenting an indication for keratoplasty (1, 2), particularly in eyes with Fuchs endothelial dystrophy. In these cases, especially in the presence of a hard lens nucleus, the touch of the endothelium by lens fragment, ultrasound energy, or the effects of the irrigating solution may have a deleterious effect on endothelial cells.

The use of viscosurgical devices in cataract surgery has minimized endothelial cell loss (3, 4); moreover, the efficacy of the use of a cohesive and a dispersive viscoelastic substance together, the soft-shell technique introduced by Arshinoff (5), to reduce corneal endothelial damage

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during cataract surgery in patients with hard lens nucleus, has been demonstrated (6).
In 1998, a new class of viscosurgical devices was created with the introduction of two viscoadaptive materials: these substances are able to change behavior depending on the turbulence of the environment (7). The development of these high rigidity ophthalmic devices offers the opportunity to perform cataract surgery in those difficult cases where the corneal endothelium has to be preserved from mechanical and ultrasonic damage.
In the current study we compared the efficacy of viscoadaptive ophthalmic viscosurgical device (OVD), 2.5% sodium hyaluronate (BD Multivisc™), with the soft shell technique in reducing corneal endothelium cell damage during cataract phacoemulsification for patients with hard lens nucleus and cornea guttata.

PATIENTS AND METHODS

This study included 37 eyes of 30 patients with Fuchs endothelial dystrophy (cornea guttata) and hard lens nucleus, graded 3 or higher following the Emery-Little classification, using system of grades 1 to 5 (8).
Patients with other ocular pathologies or intraoperative complications were not included.
Patients were randomly divided into two groups: Group A, 19 eyes, had phacoemulsification and intraocular lens (IOL) implantation with the soft-shell technique with Biolon® (sodium hyaluronate 1%) and Viscoat® (sodium hyaluronate 3%–chondroitin sulfate 4%); Group B, 18 eyes, had BD Multivisc™ alone. Examiners were masked regarding the surgical technique. The soft-shell technique is a procedure with the simultaneous use of two fluids, with different physical properties, to achieve surgical results that could not be obtained with a single OVD. We decided to modify the original soft-shell technique proposed by Arshinoff (5), based on the use of Provisc® and Viscoat®, using Biolon®, which has similar rheologic properties as Provisc® and Viscoat®.
BD Multivisc™ is considered a viscoadaptive OVD (5) and it is marketed in Canada as IVisc Phaco® and in other countries as MicroVisc®.
Phacoemulsification was performed in all eyes by the same surgeon (F.F.) with the same surgical procedure: topical anesthesia of lidocaine hydrochloride 4%, 3.2 mm temporal corneal incision, the stop and chop phacoemulsification technique, a Legacy 20,000® unit (Alcon Laboratories), a Kelman-type micro tip, and standard machine parameters with burst mode.
The OVDs were completely removed from the anterior chamber and the capsular bag with an I/A tip with a two-compartments technique (9).
In the soft shell technique group 0.1 mL of Viscoat® was injected into the anterior chamber and 0.1 mL of Biolon® was injected below the Viscoat®.
In Group B, approximately 0.15 mL of BD Multivisc™ was injected into the anterior chamber. To perform the capsulorhexis, 0.05 mL of balanced salt solution (BSS) was usually injected under the OVD to create the space for the capsulorhexis forceps and to easily control the rhexis.
Each patient in both groups was given ocular drops preoperatively and postoperatively as routinely performed: ofloxacin and diclofenac twice a day the day before surgery and once the day of surgery, ofloxacin and an association of chloramphenicol-dexamethasone four times a day after surgery; no IOP-reducing agents were instilled after surgery.
Patients were evaluated preoperatively and after 1, 15, 90, and 180 days, checked for best-corrected visual acuity (BCVA), intraocular pressure (IOP), central corneal thickness, and corneal endothelial density. IOP was measured with an applanation tonometer (Goldmann) at each visit; central corneal thickness measurements were done with the Altair Optikon ultrasound pachymeter preoperatively and at 15, 30, 90, and 180 days after surgery. Corneal endothelial density was measured with a noncontact specular microscope (Konan Robo Noncon) preoperatively and at 90 and 180 days after surgery. The area investigated was the central or the area around the optical axis where the contours of the cells could be defined more clearly.
To overcome the difficulty to exactly measure the number of cells per picture, because of the high grade of the corneal dystrophy in the majority of cases, we measured the density of the dark areas following the Kitagawa scale (10). The density of the dark areas was divided into three grades: Grade 1, sparse with the total size of the dark areas amounting to less than 1/3 in the picture; Grade 2, the total size of the dark areas occupying up to 2/3; and Grade 3, the total size of the dark areas exceeding 2/3.
Intraoperative parameters, total ultrasound time and energy in standard and Advantec mode, and BSS quantity were recorded for every patient. Continuous variables are expressed as means ± SD and analyzed by *t* test with Bonferroni correction and repeated measure analysis of

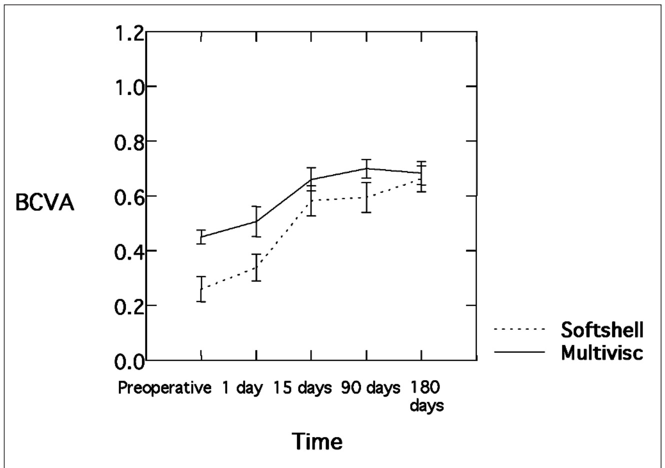

Fig. 1 - *Change in best-corrected visual acuity after cataract surgery.*

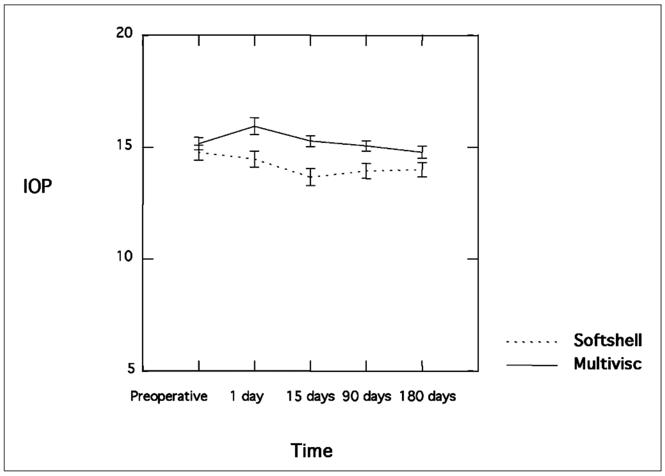

Fig. 2 - *Change in mean intraocular pressure values after surgery.*

variance, as appropriate. Line bars in graphs are SE for convenience.

Corneal endothelial density before and after surgery is analyzed by the McNemar test of symmetry. Statistical significance is considered when p<0.05.

RESULTS

The study population consisted of 37 eyes of 30 patients. Age was not different between groups (74±10 years in Group A versus 77±8 years in Group B, p=0.293).

All the patients showed an increase in BCVA at 15, 90, and 180 days. Preoperative BCVA differed significantly between groups (0.45±0.10 and 0.26±0.18, respectively, for Groups B and A) (p=0.001).

Postoperative BCVA did not differ between groups at any time point evaluation, but the improvement of BCVA through time was significantly greater for Group A than for Group B (p=0.046; Fig. 1).

In both groups postoperative BCVA did not differ significantly from preoperative values after 1 day, but did after 15, 90, and 180 days (p<0.001) (Fig. 1).

Preoperative IOP did not differ between groups (15±1 for both groups) (p=0.351). On the other hand, postoperative IOP was significantly lower in Group A than in Group B 1 (p=0.031), 15 (p=0.004), and 90 (p=0.041) days after surgery, while it was similar in both groups 180 days after surgery (p=0.328) (Fig. 2). The time course of postoperative IOP was not statistically different in the two groups. In

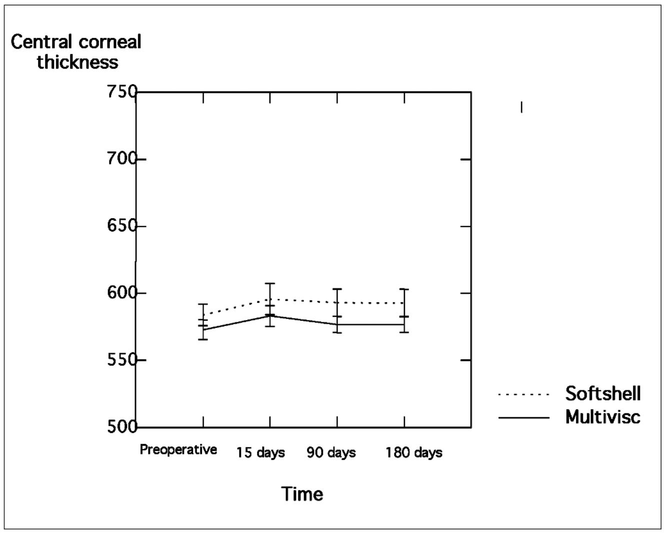

Fig. 3 - *Overall change in corneal thickness, 15, 90, and 180 days after surgery compared to preoperatively. Central corneal thickness 15 days after surgery was significantly higher than preoperative in both groups (p=0.007 in Group B; p=0.038 in Group A). At 90 and 180 days after surgery, values were not different from preoperative in both groups.*

Group B, IOP was different (higher) from preoperative IOP only 1 day after surgery (p=0.018). In Group A, IOP was different (lower) from preoperative IOP 15 (p=0.008), 90 (p=0.029), and 180 (p=0.005) days after surgery. One day after surgery, none of the patients showed a serious increase in IOP (Fig. 2).

Preoperative central corneal thickness did not differ between groups (573±30 and 584±30, respectively, for

Groups B and A) (p=0.305).

Postoperative central corneal thickness did not differ between groups at any time point evaluation, and modification of central corneal thickness through time was similar in both groups (p=0.554). Central corneal thickness 15 days after surgery was significantly higher than preoperatively in both groups (581±32 versus 573±30, p=0.007, in Group B; 596±44 versus 584±30, p=0.038, in Group A). Ninety and 180 days after surgery, values were not different from preoperative in either group (Fig. 3).

Corneal endothelial density did not differ between groups in the preoperative or in the postoperative evaluation. Seven eyes out of Group A were classified as grade 1, 4 as grade 2, and 7 as grade 3. In Group B, 4 eyes were classified as grade 1, 5 as grade 2, and 10 as grade 3. In both groups postoperative values did not differ significantly from preoperative. As a matter of fact, corneal endothelial density changed from pre- to postoperative evaluation only in three cases in Group B (passing from grade 1 to grade 2) and in two cases in Group A (one passing from grade 1 to grade 2 and one from grade 2 to grade 3). No patient showed in this follow-up a persistent corneal edema or a progression to bullous keratopathy or needed a corneal graft.

Ultrasound energy (%) and time (sec) did not differ between groups (p=0.313 and 0.147, respectively) (Tab. I). Time of surgery was 11.7±3.3 min for Group B and 12.5±3.5 for Group A (p=0.5).

Mean BSS quantity was 138.3±42.4 mL with no statistical difference between the two groups.

DISCUSSION

Fuchs endothelial dystrophy is one of the leading indications for corneal transplantation (11, 12).

Cataract surgery performed in these eyes presenting hard nucleus increases the risk of corneal decompensation, although endothelial cell loss has been minimized by the use of OVDs.

Efficacy of the soft-shell technique has been demonstrated (6); this surgical procedure allows the surgeon to have the advantages of both cohesive and dispersive OVDs, minimizing the disadvantages.

Viscoadaptive substances have been recently introduced in ophthalmic surgery, especially cataract surgery, because of their ability to change from a high viscosity profile at a low shear rate to fracturable at higher shear rate, assuming pseudodispersive behavior (5, 7).

In cases of hard nucleus cataract soft-shell technique has been demonstrated to be safe and effective in protecting endothelial corneal layer (6).

In this study, mean central corneal thickness had a slight increase at 15 days after surgery in the two groups but remained stable during the follow-up.

The difference between groups in preoperative BCVA is attributable not only to different grades of cataract but also to the difficult assessment of the exact refraction due to the opacification of the lens.

Often the clinical slit lamp evaluation of the nuclear density is not confirmed by the intraoperative assessment and grading assessment is jeopardized by the severity of the opacity. For this reason we enrolled patients showing cataract nuclear density graded 3 or higher according to the Emery-Little classification and we did not perform any further subclassification.

We noticed a progressive postoperative improvement in BCVA in both groups, although a greater improvement was apparent in Group A, which had lower preoperative values.

Ultrasound energy and time and global time of surgery did not differ between groups. The global time of surgery is highly influenced by various variables, such as the time required to fold IOL or to check the tightness of the incision without influencing the endothelial cells integrity.

IOP represents one of the major complications correlated with the intraocular use of OVDs (13, 14), especially dispersive, such as Viscoat, and viscoadaptive, such as Multivisc. In our study none of the patients had a serious IOP increase the first day after surgery or at follow-up and no patient was given IOP-reducing topical or systemic agents. However, the

TABLE I - INTRAOPERATIVE PARAMETERS

Intraoperative parameters	Mean US power	Mean US time	Mean US power, Advantec mode	Mean US time, Advantec mode
Soft-shell	19.9±7.3	78.4±32.4	39.3±10.8	18±9.9
MultiviscTM	24.72±11.7	62±17.4	36.9±10.5	16.1±11

US = Ultrasound

day after surgery and during the follow-up, Group B demonstrated a higher IOP than Group A. This IOP elevation, as reported by Arshinoff and Wong (15), probably can be correlated to the fractured OVD remaining in the eye resistant to rapid aspiration of I/A phase or to frequent escape from the clutch of the aspirating port when positioned behind the IOL.
Endothelial cell loss was monitored postoperatively, checking the density of dark areas in the picture: in fact, in most of the cases, endothelial cells count was not performed because of the dystrophy stage. Endothelial cells count is one of the major problems in such cases of high grade of Fuchs endothelial dystrophy. The technique we used, although not exact, confirmed that endothelial cell loss is limited when using these OVDs during cataract surgery, even in these challenging cases. In addition, recently, Seitzmann et al (16) suggested new recommendations for initial triple procedure in eyes with Fuchs dystrophy and cataract: considering as cut-off value a preoperative cornea thickness of 640 μm, a larger number of patients can be addressed first at cataract surgery alone, and only in case of corneal decompensation or insufficient visual acuity, to undergo a secondary keratoplasty.
In conclusion, our results strengthen these recommendations and suggest that both the soft-shell technique and MultiviscTM are effective in protecting endothelial layer and are safe in eyes with Fuchs dystrophy and hard lens nucleus; the evolution of cataract surgery and OVDs allows in many of these cases to avoid combined penetrating keratoplasty and cataract extraction as first choice, and to eventually reserve corneal transplantation in case of decompensation or inadequate visual acuity.

No author has any commercial interest in this study.

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