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ORIGINAL PAPER

Combined Cataract and Corneal Transplantation Surgery Without Viscosurgical Devices

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ABSTRACT

Background: The most common complications after performing the triple Descemet's stripping automated endothelial keratoplasty (DSAEK), which combines the cataract phacoemulsification, intraocular lens implantation and DSAEK procedure, are detachment or decentration of the donor lamella and postoperative interface haze. One reason for this is the retained viscoelastic used during surgery. **Objective:** This study aimed to describe triple DSAEK procedure without the usage of viscoelastic and to discuss its potential benefits on surgical outcomes. **Methods:** The surgical procedures and outcomes of patients with Fuchs' dystrophy and lens opacification who underwent the triple DSAEK were retrospectively reviewed. The surgical procedure was described, and postoperative complications were studied. **Results:** The study included 10 eyes of 10 patients. Capsulorhexis and IOL implantation performed in locally potentiated anesthesia compared to general anesthesia did not significantly differ (P > 0,05). The mean preoperative best-corrected visual acuity was 0.75 LogMar. The mean postoperative best-corrected visual acuity was 0.2 LogMar. The central graft thickness before surgery was 129.6 μm and 6 months after surgery was 114.2 μm. Successful attachment of the donor lamellae was observed in all 10 patients. None of the patients had postoperative interface haze or any other possible viscoelastic caused complication. **Conclusion:** Although viscoelastic can facilitate certain aspects of the triple DSAEK procedure, we conclude that this procedure can be performed completely without its use. If performed by a trained surgeon, the procedure can be feasible without the complications of donor lamella detachment, decentration, or interface haze.

Keywords: Triple procedure, Viscoelastic, DSAEK, Phacoemulsification.

1. BACKGROUND

The triple procedure combining phacoemulsification, intraocular lens (IOL) implantation and Descemet's stripping automated endothelial keratoplasty (DSAEK) in patients with Fuchs' dystrophy (FECD) and cataract provides more rapid visual improvement. The additional advantage is the avoidance of second surgical procedure. In patients with FECD and cataracts requiring both DSAEK and cataract surgery, operation can be performed concurrently or sequentially with DSAEK shortly after phacoemulsification and IOL implantation (1).

Many ophthalmic viscosurgical devices (OVDs) are used worldwide to facilitate cataract surgery. The advantages of viscoelastic during cataract surgery are well known, and phacoemulsification and IOL implantation without the use of viscoelastic are not performed in everyday surgical practice. The main viscoelastic function is to maintain anterior chamber depth, facilitate capsulorhexis, protect and stabilize intraocular tissues (corneal endothelium and the posterior capsule) and facilitate IOL implantation. A deep anterior chamber reduces the chance of donor endothelial contact with the iris and IOL (2).

The use of viscoelastic during DSAEK can simplify descementorhexis in certain cases (3). However, some potential side effects of residual OVDs have been observed postoperatively after cataract surgery as well as DSAEK. Residual viscoelastic can cause increased intraocular pressure owing to the blockage of

the trabecular meshwork and postoperative elevated intraocular eye pressure, toxic anterior segment syndrome (TASS), and posterior capsule opacification (4-7). OVD needs to be completely removed at the end of the surgery, which increases the duration of surgery. Moreover, viscoelastic substances increase the final cost of surgery. In cases of the DSAEK procedure, regardless combined with phacoemulsification or not residual viscoelastic may remain at the graft-host interface. One of the most common complication of DSAEK is graft detachment, with average incidence rate of 15% (8, 9). The causes of graft dislocation can be multifactorial and include tissue storage conditions, surgical techniques, pre-existing conditions and lack of patient cooperation. It is suggested that surgeons should minimize the amount of viscoelastic used during procedure(10). Retained viscoelastic may impact graft adherence and lead to posterior graft dislocation and detachment (11). Poor graft adherence can also cause graft failure and rejection (12, 13). Further, retained viscoelastic can affect visual outcomes by producing haze at the interface. Several authors reported cases of residual viscoelastic as a direct cause of interface haze(12, 14), however there is a lack of studies which show exact rate of viscoelastic caused graft dislocation and detachment. To the best of our knowledge, there is insufficient information about performing the triple DSAEK procedure without any viscoelastic.

2. OBJECTIVE

Our study aimed to describe the triple DSAEK procedure without viscoelastic agents and to discuss its potential benefits on surgical outcomes. Further, we aimed to investigate whether we would have above mentioned complications if we avoided the use of viscoelastic.

3. MATERIAL AND METHODS

A retrospective analysis (retrospective chart review) of the medical records of patients who underwent a triple procedure, including phacoemulsification, IOL implantation, and DSAEK without ophthalmic viscosurgical devices, was conducted. Ethical committee approval was obtained from the institution before performing the research.

The operations were performed by a single surgeon at a single tertiary referral center. All participants were diagnosed with Fuchs' endothelial dystrophy grade 4–6 and nuclear opacification (NO3, NO4, or NO5), and cortical opacification (C2 or C3), according to the Lens Opacities Classification System III scale. Ten eyes of 10 patients who underwent the triple procedure without viscoelastic treatment were identified. The patients did not have concomitant ophthalmic diseases, such as glaucoma or retinal diseases. Patients with a postoperative follow-up period of < 6 months were excluded.

Demographic data such as sex and age at the time of diagnosis were recorded.

The patients underwent complete ophthalmological examination preoperatively and postoperatively (6 months), which included best-corrected visual acuity measured (Snellen table, ETDRS – logMAR table), slit-lamp examination, Goldmann tonometry, and fundus examination. The thickness of the lamella and cornea were measured with anterior segment optical coherence tomography (OCT) Visante (Carl Zeiss Meditec, Jena, Germany).

Patients underwent phacoemulsification with IOL implantation and DSAEK (triple procedure), IOL power calculation using IOL Master 700 (Carl Zeiss, Jena, Germany), and SRK/T formula. After the triple DSAEK occurs hyperopic shift, which we calculated during IOL measurement. Implanted IOLs were +1.25 diopters higher, which compensated for the reduction in corneal power by DSAEK.

Donor corneal lamellas were precut and preserved using conventional eye bank techniques. The corneas were stored in the eye bank in either hypothermic storage or tissue culture media. Corneas in a hypothermic storage medium were stored at a temperature of 4°C for a maximum of seven days, and were then prepared for lamellar keratoplasty immediately before planned operation. The other corneas were kept in a tissue culture media at a temperature of 31°C for a maximum of 28 days. Corneas in the storage become thicker and in order to return to the physiological thickness, it must be stored in a transmedia containing dextran, for at least for 24 hr before the preparation for lamellar keratoplasty. The corneas were microbiologicly tested during storage. The procedure of preparing corneas for lamellar keratoplasty was performed by specially trained employees using the automatic microkeratome (Gebauer Slc Original, Neuhausen, Germany). Each cornea was placed on the artificial eye chamber filled with corneal storage media to preserve the endothelial cell viability. The epithelium of each cornea was removed to make the cut as precise as possible. The permissible variation of the knife, which was 30 μm, should be considered. The cornea was carefully removed from the artificial eye chamber and stored in a transport media for delivery to transplantation center.

The surgeries were performed under general anesthesia or locally potentiated anesthesia.

One side port entrance made at the beginning of the cataract surgery at the 6 o'clock position was used for continuous irrigation with the balanced salt solution (BSS). The bottle was raised to a height of 60–80 cm of water and adjusted according to the anterior chamber depth. The other side port was made at the 2 o'clock position for the chopper. Capsulorhexis was started using a 26-gauge cystitome needle and continued with forceps under BSS irrigation through the main 2.75 mm port at the 12 o'clock position. Stop and chop phacoemulsification were performed using the Alcon Centurion device (Alcon, Fort Worth, TX, USA). IOL implantation (Johnson & Johnson Sensar One-piece AAB00) into the capsular bag was performed under continuous BSS irrigation. The cartridge was also filled with BSS.

Based on the surgeons' personal experience, we graded the complexity of performing capsulorhexis without viscoelastic during the procedure from 1 to 3, where 1 = easy, 2 = moderate, and 3 = difficult to perform. The same gradation was used with IOL implantation (1 = easy; 2 = moderate; and 3 = difficult to implant) (Table 1).

After phacoemulsification and IOL implantation, Miostat (Carbachol 0.01%, Alcon) was injected into the anterior chamber to perform miosis. Subsequently, under continuous irrigation, peripheral iridotomy at the 6 o'clock position was performed with vertical vitreoretinal scissors to avoid the potential postoperative pupillary block.

An 8.0 mm diameter descemetorhexis under an air bubble

Complexity grade	Capsulorexis	IOL implantation
Easy (grade 1)	Continuous capsulorexis in one act	IOL implantation in one act
Moderate (grade 2)	Discontinuation of capsulorexis 1-2 times and waiting for formation of the anterior chamber	Short-term collapse of the anterior chamber
Difficult (grade 3)	Multiple discontinuation of capsulorexis >2 times and waiting for formation of the anterior chamber	Short-term collapse of the anterior chamber with difficulty positioning the IOL

Table 1. Criteria used to evaluate complexity grade of performing capsulorhexis and IOL implantation without viscoelastic.

Complexity grade	Easy	Moderate	Difficult	Fisher's exact test
Capsulorexis:				
GA	3	2	0	
LPA	2	2	1	
Total	5	4	1	P > 0,05
IOL implantation:				
GA	3	2	0	
LPA	2	2	1	
Total	5	4	1	P > 0,05

Table 2. Gradation of the complexity of performing capsulorhexis and IOL implantation based on surgeons' personal experience. GA – general anesthesia; LPA – locally potentiated anesthesia; IOL – intraocular lens.

was made by the reverse Sinskey hook through the side port at the 2 o'clock position. The central part of the Descemet membrane was removed from the eye using endothelial 23-gauge grasping forceps.

An 8.0 mm trephine was used to separate the donor graft lamella. A Busin glider was used to insert the donor graft into the anterior chamber through the main incision. Air bubble was then injected into the anterior chamber to attach the graft to the stroma. Finally, reconstituted cefuroxime (1 mg/0.1 mL) was injected into the anterior chamber. We performed control examinations of the patients after 8 hours, the next day, in 7 days, in 2 weeks, and then every month after the procedure. Postoperative follow up was without complications.

After obtaining the necessary data, statistical analysis was conducted. SPSS for Windows (version 13.0, SPSS Inc. Chicago, IL, USA) and Microsoft Excel (version of Office 2007; Microsoft Corporation, Redmond, WA, USA) were used. Data are expressed as counts and percentages for categorical variables and as means with standard deviations or medians with ranges for continuous variables. Fisher's exact test was used to analyze the differences between categorical variables. Statistical significance was set at P<0.05.

4. RESULTS

The present study included 10 eyes of 10 patients. Within the study population, there were nine women and one man. The mean age of the patients who underwent the procedure was 68 years (range 54–81 years). Four patients had Fuchs' dystrophy grade 4, four had Fuchs' dystrophy grade 5, and two presented with grade 6. The mean preoperative best-corrected visual acuity was 0.75 LogMar, ranging from 1.3 to 0.5 LogMar. The central graft thickness before surgery, measured by ultrasound pachymetry, ranged from 101 to 165 μm, with a mean of 129.6 μm. The central graft thickness 6 months after surgery, measured by anterior OCT, ranged from 89 to 135 μm, mean of 114.2 μm.

Gradation of the complexity of performing capsulorhexis and IOL implantation in general and locally potentiated anesthesia is shown in Table 1. As seen from the Table 2, both capsulorhexis and IOL implantation performed in locally potentiated anesthesia compared to general anesthesia did not significantly differ (P > 0,05).

The mean postoperative best-corrected visual acuity was 0.2 LogMar, ranging from 0.22 to 0.1 LogMar. The mean intraocular pressure (IOP) on the first postoperative day measured with Goldman applanation tonometry was 14.6 mmHg, ranging from 12 to 18 mmHg. 6None of the patients had postoperative complications, including graft dislocation and interface fluid; therefore, none of the patients underwent postoperative rebubbling. In addition, none of the patients experienced interfacial haze.

5. DISCUSSION

The most common complications of DSAEK surgery are graft dislocation and detachment (8, 12, 13). These complications usually require rebubbling or recentering the graft postoperatively. The American Academy of Ophthalmology reports a wide range frequency of detachment after DSAEK, from 0% to 82%; however, the average rates are approximately 15% (8). The rebubbling rate differs among studies from 5% to 50% (15).

Various potential causes of graft dislocation or detachment are mentioned in the literature, such as improper tissue storage conditions, surgical techniques and patients preexisting conditions. Postoperative patient behavior is also important as some patients can squeeze and rub their eyes which leads to potential graft dislocation (9, 16-18). Among the many causes of graft dislocation and detachment, one of them could be viscoelastic, which is used during surgery. OVDs used during the triple procedure should be completely evacuated because incomplete removal and retained viscoelastic disables good adherence of donor cornea to the recipient stroma and may lead to graft dislocation or detachment. It is also suggested that surgeons should minimize the amount of viscoelastic used during procedure (10). By analyzing literature, we found case reports of residual viscoelastic as a direct cause of interface haze (12, 14). However, we did not find empirical data on exact incidence of residual viscoelastic causing graft dislocation and detachment. Further, in cases of retained viscoelastic after DSAEK, as shown by certain cases in partial detachment, surgeons recommend removal in second surgical procedure to minimize interface haze (12). Our idea was to remove the viscoelastic as one of the potential causes of above mentioned complications during the triple DSAEK procedure, since other causes are difficult to influence (such as postoperative patient behavior, donor tissue quality). We wondered what percentage of graft dislocation and detachment would be if we completely excluded the viscoelastic from the triple DSAEK procedure.

Owing to possible complications, many surgeons avoid use of OVDs during DSAEK; however, the triple procedure includes phacoemulsification in which viscoelastic is used almost inevitably for safe capsulorhexis and IOL implantation (19).

To the best of our knowledge, this is the first report on a triple procedure without viscoelastic in the literature. Several studies have been conducted on phacoemulsification without the use of viscoelastic (20-25). Goles et al. indicated that phacoemulsification can be performed by trained surgeons without viscoelastic with the same level of safety regarding endothelial cell damage (23). These studies claimed that phacoemulsification without viscoelastic is safe, with very low postoperative complications. Moreover, the reduced time of the surgery and the reduced costs of procedures stand out as advantages.

Prompted by possible complications and encouraged by phacoemulsification studies without viscoelastic, we started to perform a triple procedure without viscoelastic agents.

In our study, all procedures were successfully performed without postoperative complications (graft dislocation or detachment, increased intraocular pressure, TASS, and interface haze). In experienced surgeon hands, three basic steps in which viscoelastic is normally used can be successfully performed without, by using a careful surgical technique. Capsulorhexis and IOL implantation in this study were performed under continuous infusion, and Descemetorexis was performed under an air bubble.

According to Table 2, it seems that capsulorexhis and IOL implantation are equal to perform under general anesthesia or locally potentiated anesthesia. In general anesthesia, the impact of patient cooperation during the procedure is minimized so it is expected that the procedure would be easier. However, if the anterior chamber is too unstable intraoperatively, we can always add viscoelastic and finish the triple DSAEK procedure with viscoelastic.

Limitations of the study

This study has several limitations. First limitation is small sample size, however it showed feasibility to conduct research with larger sample size. Basing on this study in larger sample size we should generate more accurate results. Considering that we do not have many patients whose condition requires a triple procedure, it is difficult to collect a larger number for research. Therefore, a multicenter study should be conducted to have a larger sample. Further, we are lacking previous studies in the this topic, and we can not compare our results with others. There are studies in the literature describing phacoemulsification surgery and DSAEK without viscoelastic, however we did not find any study about triple DSAEK procedure without viscoelastic.

6. CONCLUSION

To the best of our knowledge, this is the first study on a triple procedure without viscoelastic in the literature. Although viscoelastic can facilitate certain parts of the operation, we can conclude that this procedure can be performed completely without its use. If performed by a trained surgeon, the procedure can be feasible without complications of donor lamella detachment, decentration, or interface haze

The future controlled trials are recommended to see if the triple DSAEK procedure without viscoelastic has fewer complications.

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- **Athors contribution:** TK: Conceptualization, Investigation, Writing–Original Draft, Writing – Review and editing. APB: Investigation, Writing–Original Draft, Visualization. AM, IG, DLG, SVP, AJ, IŠ, SM, MK: Resources, Review and editing.
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