doi: 10.17116/engoftalma20151313-2

Differentiated approach to hybrid phacoemulsification in small pupils

K.S. AVETISOV

Scientific Research Institute of Eye Diseases, 11 A,B Rossolimo St., Moscow, Russian Federation, 119021

Aim – to develop a differentiated approach to hybrid phacoemulsification (PE) in small pupils. **Material and methods**. Modified hybrid PE was performed in 119 patients (130 eyes) with conditionally small pupils (preoperative dilated pupil diameter of less than 5.5 mm). **Results**. A differentiated approach to hybrid PE has been developed and tested in patients with poor preoperative mydriasis. **Conclusions**. Small rigid pupils are considered a relative contraindication to hybrid PE. Developed modifications enable less surgical trauma with effective phacoemulsification time generally unchanged, while the latter is usually increased in standard PE in patients with poor preoperative pupil dilation.

***Keywords**: cataract, femtosecond laser, hybrid phacoemulsification, mydriasis, anterior capsulorhexis, nucleus fragmentation.*

Vestnik oftal'mologii 2015; 3: 61-63

Adequate drug-induced mydriasis is one of the main factors that determine minimum surgical trauma and high level of safety of ultrasound phacoemulsification (PE). A small pupil significantly increases the number of potential complications (mostly those that are due to disrupted integrity of the posterior lens capsule and Zinn's zonules) and also increases the length of intervention, effective phacoemulsification time, and, thus, surgical trauma. The risk of complications is even higher in small rigid pupils combined with lens subluxation, as it is seen in pseudoexfoliation syndrome in particular, which is a rather common condition in the elderly. Hence, a number of methods and tools aimed at prevention of possible PE complications have been proposed [1—6].

Hybrid PE incorporates both femtosecond (FS) laser and classic ultrasound technologies and allows to perform some complication-prone technical steps (namely, round anterior capsulorhexis and fragmentation of the lens nucleus) on a "closed" eyeball [7—9].

However, the said advantage of hybrid technology can as well be negated to some extent by poor preoperative pupil dilation. The problem is that femtosecond laser operating specifics preclude mechanical iris retraction, since it involves opening of the anterior chamber. Therefore, attempts are being made to optimize the femtosecond laser stage of PE so that it could be still performed in poor mydriasis (dilated pupil diameter of less than 5.5 mm), which is yet considered a relative contraindication to this type of surgery [10-—11].

The **aim** of the present study was to develop a differentiated approach to hybrid phacoemulsification technique in small pupils.

Material and methods

Hybrid PE was performed in 119 patients (130 eyes) with the mean age of 67.1±2.3 years (59 to 79 years). Post-operative follow-up period ranged from 3 to 6 months. In 97 cases (64.3%) the nuclei were grade 3 in terms of their density (Buratto's classification), while 54 cases (35.7%) conformed to grade 4. The patients were divided into two groups in accordance with our objectives. The main group included 87 patients (94 eyes), in whom the preoperative drug-induced mydriasis was viewed as insufficient for standard hybrid PE; particularly, 37 eyes with dilated pupil diameter of 4.6—5.5 mm, 31 eyes with dilated pupil diameter of 4—4.5 mm, and 19 eyes with < 4 mm diameter pupils. The control group consisted of 32 patients (36 eyes), in whom preoperative mydriasis was adequate (over 6.0 mm in diameter), thus, allowing to perform standard hybrid PE.

In order to achieve the maximum possible mydriasis, all the patients were prescribed inhibitors of prostaglandin synthesis in eye drops (t.i.d. for 3 days and 3 times just before surgery). This measure aimed to prevent intraoperative constriction of the pupil due to femtosecond-laser-induced release of prostaglandins. Moreover, preoperative mydriatics were chosen that affect both pupillary sphincter and pupillary dilator.

Patients with hypermature cataract, lens subluxation, concomitant severe diabetes mellitus and those after previous surgical intervention on the eyeball were not enrolled.

Conventional ophthalmic assessment was performed before and in different terms after the surgery. The first follow-up examination included subjective and biomicroscopic evaluation of corneal condition and transparency.

Anterior capsulorhexis and prefragmentation of the nucleus were performed with VICTUS femtosecond laser

For correspondence:
Konstantin Sergeevich Avetisov, MD, PhD, leading researcher
e-mail: info@eyeacademy.ru

(Technolas Perfect Vision, Germany). Stellaris phacosystem (Baush&Lomb, USA) was further used for emulsification of nuclear fragments and irrigation/aspiration of cortical masses. Time interval between the femtosecond laser step and the beginning of nucleus emulsification was no more than 15 minutes (5 to 14 minutes). In all patients hydrophobic acryl intraocular lenses (IOL) with intracapsular fixation were implanted. Viscoelastics were the same in all cases.

The following parameters were evaluated intraoperatively in both groups: the ultrasonic power level and exposure time as well as the volume of irrigation solution spent for emulsification of nuclear fragments and irrigation/aspiration of cortical masses. Standardization of the results was achieved by calculating the effective phacoemulsification time in all cases. The latter is the product of ultrasound power level and active time of the ultrasonic tip.

Nonparametric methods we used for statistical analysis of the results.

Results and discussion

In order to minimize surgical trauma and to prevent possible intraoperative and postoperative complications, we have developed a differentiated approach to performing hybrid PE, in which the degree of preoperative mydriasis is the key decision criterion.

In cases of 4.6—5.5 mm preoperative mydriasis, we performed a 5 mm diameter round capsulorhexis with femtosecond laser set at 6,700 nJ and centered by the pupil. Parameters of nucleus fragmentation were adjusted based on nucleus density. At any rate we performed a 3 mm diameter circular dissection in the center of the nucleus and then divided the matter into 8 fragments that were further emulsified starting from the center. Preliminary laser treatment of the central nucleus facilitated and accelerated the removal of nuclear fragments. Finally, irrigation/aspiration of cortical masses was performed and an artificial lens was inserted into the capsular sac.

In cases of 4—4.5 mm dilated pupil diameter, a 4 mm opening was formed in the anterior capsule, laser settings being the same as described above. Nucleus fragmentation, fragment emulsification, and IOL implantation followed. As the lens was implanted, we deepened the anterior chamber with a viscoelastic substance. In order to prevent retraction of the anterior capsule, we also expanded the capsulorhexis (up to 5—5.5 mm in diameter) with forceps taking care that the optic edge of the IOL remained covered with the anterior capsule.

If the dilated pupil was less than 4 mm in diameter, we first performed the fragmentation step (2.5 mm diameter central circular dissection with 8 radial cuts). Then according to the conventional technique we made the main valve-like limbal incision and performed manual 5—5.5 mm diameter round anterior capsulorhexis. At this point extra dilation of <3 mm diameter pupils aimed at prevention of potential complication was attempted using 4 elastic curved retractor hooks [5, 6]. In cases of >3 mm pupil diameter no hooks were applied, however, a second tool was inserted through a corneal paracentesis for iris retraction during emulsification of nuclear fragments and irrigation/aspiration of cortical masses. Emulsification of nuclear fragments began from the center like in other cases. After the removal of nuclear fragments artificial lenses with intracapsular fixation were implanted.

The developed differentiated approach to performing hybrid PE allowed us to avoid serious complications in almost all cases. Partial tear of Zinn's zonules occurred in one case, but did not prevent the IOL from being placed within the capsular bag after a capsular ring was implanted. Local damage of the pupil edge resulting from the use of the second tool for iris retraction was observed in two cases of <3 mm preoperative mydriasis. No other intraoperative complications were noted.

Other conditions being equal, poor pupil dilation is usually associated with increased effective phacoemulsification times and irrigation solution volumes as compared to adequate mydriasis. In this study, however, we observed only a small and statistically unreliable increase in effective phaco time. Thus, in grade 3 nuclei from the main group it averaged 2.17±0.41 sec vs. 2.04±0.37 sec in the corresponding controls, which means just a 6.4% increase. As for grade 4 nuclei, their effective phaco time was 4.27±0.93 sec in the main group compared to 3.95±0.81 sec in the controls (8.1% increase). The volume of irrigation solution required for emulsification of nuclear fragments and irrigation/aspiration of cortical masses was noted to be 17.1% higher than usual if a modified hybrid PE was performed. In our experience, however, standard PE in an eye with poor mydriasis can also be associated with an increase in irrigation solution volume by the average of 27.3%.

There were no postoperative complications in any of the patients and the inflammatory response to surgery was not at all pronounced. Slit-lamp examination on the first day after surgery revealed a completely transparent cornea in 86.6% of cases with grade 3 nucleus density and 81.5% of cases with that of grade 4.

Conclusions

1. Small rigid pupil is a relative contraindication for hybrid PE.
2. Developed modifications of hybrid PE enable less surgical trauma in patients with poor preoperative pupil dilation.
3. With new modifications, the effective phacoemulsification time appears generally unchanged, despite usually being longer in standard PE in eyes with small pupils.

The author declares no conflict of interests.

REFERENCES

1. Avetisov S.E., Yusef Yu.N., Mamikonyan V.R., Vvedensky A.S., Yusef S.N., Mutonen N.V. Original method of exocapsular nuclear phacofragmentation in phacoemulsification. Vestnik oftal'mologii [Annals of ophthalmology]. 2002; 118 (5): 18 – 21. (In Russ.)
2. Voronin G.V., Mashkova N.A. The first experience of iris-fixated lens implantation in patients with open-angle glaucoma. Vestnik oftal'mologii [Annals of ophthalmology]. 2012; 128 (6): 38 – 40. (In Russ.)
3. Malyugin B.E. Mediko-tehnologicheskaja sistema hirurgicheskoj reabilitacii pacientov s kataraktoj na osnove ul'trazvukovoj fakojemul'sifikacii s implantaciej intraokuljarnoj linzy. Diss. Dokt. Med. Nauk [Medical and technological system of surgical rehabilitation of cataract patients on the basis of ultrasound phacoemulsification with intraocular lens implantation]. Dr. Diss. (Med. Sci.). Moscow, 2002. (In Russ.)
4. Malyugin B.E. Cataract surgery and intraocular aphakic correction: progress, problems, and prospects. Vestnik oftal'mologii [Annals of ophthalmology]. 2006; 122 (1): 37 – 41. (In Russ.)
5. Yusef Yu.N. [Phacoemulsification with zonular lens defects] Materialy Pervogo Rossiyskogo simpoziuma po refraktsionnoy khirurgii [Proceedingt of the First Russian symposium on refractive surgery]. Moscow, 1999, p. 22. (In Russ.)
6. Yusef Yu.N. O novyh vozmozhnostjah usovershenstvovanija sovremennoj fakojemul'sifikacii pri razlichnyh vidah katarakt Diss. Dokt. Med. Nauk [New opportunities to improve modern phacoemulsification in different types of cataracts]. Dr. Diss. (Med. Sci.). Moscow, 2000. (In Russ.)
7. Donaldson K., Braga-Mele R., Cabot F., Davidson R., Dhalival D., Jackson M., Hamiltom R., Palterson L., Stonecipher K., Yoo S. Femtosecond laser-assisted cataract surgery. J Cataract Refract Surg. 2013; 39: 1753 – 1763. doi:10.3928/1081597x-20091117-04.
8. Nagy Z. Initial clinical evaluation of an intraocular femtosecond laser in cataract surgery. J Refract Surg. 2009; 25: 1053 – 1060. doi:10.1016/j.jcrs.2013.05.035.
9. Reddy K., Kandulla J., Auffarth G. Effectivness and safety of femtosecond laser-assisted lens fragmentation and anterior capsulotomy versus manual technique in cataract surgery. J Cataract Refract Surg. 2013; 39: 1297 – 1306. doi:10.1016/j.jcrs.2013.05.034.
10. Conrad –Hengerer I., Hengerer F., Schultz T., Dick H. Femtosecond laser-assisted cataract surgery in eyes with a small pupil. J Cataract Refract Surg. 2013; 39: 1314 – 1320.
11. Dick H., Schultz T. Laser-assisted cataract surgery in small pupils using mechanical dilation devices. J Refract Surg. 2013; 29: 858 – 862. doi:10.3928/1081597x-20131115-06.