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# ON THE TECHNIQUE OF LENS NUCLEUS FRACTURE IN PHACOEMULSIFICATION

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## SUMMARY

**Purpose** – to propose an advanced technique for lens nucleus fracture in phacoemulsification (FE).

**Material and methods**

The proposed method was tested on 58 patients of the main group, who underwent FE according to an advanced technique (aFE), 56 patients made up the control group with standard FE (phacochop). All the patients underwent a conventional comprehensive ophthalmological examination.

**Results**

There was a reduction in the total (in average by 39.0%) and torsion (by 33.3%) ultrasound time (US), aspiration time (by 26.1%), as well as the number of intra– and postoperative complications – from 6.1% to 9.2% - compared with standard FE. The density of endothelial cell turned out to be lower: after 1 month – by 136.42 and 154.49 c/mm2, after 1 year – by 174.14 versus 206.64, respectively.

**Conclusion**

The proposed technique of lens nucleus fracture in FE helps to reduce the total time of energy load and the time of torsion ultrasound, as well as the aspiration time, which contributed to a decrease in intra- and postoperative complications by 1.5 times compared with the standard technique.

**Key words:** *cataract phacoemulsification, modified technique of lens nucleus fracture, reduction of energy load on ocular tissue, reduction of complications*

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# KATARAKTANIN FAKOEMULSİFİKASİYASI ZAMANI BÜLLUR NÜVƏSİNİN PARÇALANMASI TEXNİKASINA DAİR

## XÜLASƏ

**Məqsəd** - kataraktanın fakoemulsifikasiyası (KFE) zamanı büllur nüvəsinin parçalanması üçün təkmilləşdirilmiş texnika təklif etməkdir.

**Material və metodlar**

Təklif olunan təkmilləşdirilmiş KFE (tKFE) texnikası əsas qrupun 58 pasiyenti üzərində sınaqdan keçirilmiş, standart KFE (fakoçop) keçirmiş 56 pasiyent nəzarət qrupunu təşkil etmişdir. Bütün pasiyentl ərənənəvi kompleks oftalmoloji müayinədən keçmişdir.

**Nəticə**

Standart KFE ilə müqayisədə ultrasəs (US) və aspirasiyanın ümumi (orta hesabla 39,0%), torsion (33,3%) vaxtının (26,1%) azalması, həmçinin əməliyyatdaxili və əməliyyatdan sonrakı ağırlaşmaların sayının (9,2%-dən 6,1%-ə qədər) azalması müşahidə edilmişdir. Endotel hüceyrələrinin sıxlığı da aşağı olmuşdur: 1 aydan sonra – müvafiq olaraq 136,42 və 154,49 hüceyrə/mm2, 1 ildən sonra – 174,14 və 206,64.

**Yekun**

Optimallaşdırılmış FE zamanı büllur nüvəsinin parçalanması texnikası göz toxumalarına enerji yükünün ümumi vaxtının və ultrasəsin torsion vaxtının üçdə birindən çox azalmasına, həmçinin aspirasiya müddətinin 1,5-ə qədər azalmasına səbəb olmuşdur. Bu da öz növbəsində standart texnika ilə müqayisədə əməliyyatdaxili və postoperativ ağırlaşmaların dəfələrlə azalmasına şərait yaratmışdır.

**Açar sözlər:** *kataraktın fakoemulsifikasiyası, büllur nüvəsinin parçalanması texnikası*

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## О ТЕХНИКЕ РАЗЛОМА ЯДРА ХРУСТАЛИКА ПРИ ФАКОЭМУЛЬСИФИКАЦИИ КАТАРАКТЫ

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РЕЗЮМЕ

**Цель** – предложить усовершенствованную технику разлома ядра хрусталика при факоэмульсификации катаракты (ФЭК).

**Материал и методы**

Предложенный способ апробирован на 58 пациентах основной группы, которым ФЭК выполнена по усовершенствованной методике (уФЭК), 56 пациентов составили контрольную группу со стандартной ФЭК (phacochop). Всем пациентам проводилось общепринятое комплексное офтальмологическое обследование.

**Результаты**

Отмечено сокращение общего (в среднем на 39,0%) и торсионного (на 33,3%) времени ультразвука (УЗ) и аспирации (на 26,1%), а также числа интра – и послеоперационных осложнений с 6,1% до 9,2% по сравнению со стандартной ФЭК. Ниже оказались и показатели плотности эндотелиальных клеток: через 1 месяц – на 136,42 и 154,49 кл/мм2, через 1 год – на 174,14 против 206,64 соответственно.

**Заключение**

Оптимизированная техника разлома ядра хрусталика при ФЭК привела к уменьшению общего времени энергетической нагрузки на ткани глаза и времени торсионного УЗ более, чем на треть, а также времени аспирации, что способствовало снижению в 1,5 раза интра- и послеоперационных осложнений в сравнении со стандартной методикой.

**Ключевые слова:** *факоэмульсификации катаракты, модифицированная техника разлома ядра хрусталика, уменьшение энергетической нагрузки на ткани глаза, уменьшение осложнений*

It is well known that the principle of lens nucleus fracture during cataract phacoemulsification (CFE), one of the most important stages of the operation, lies in 2 the most well-known techniques involving manual separation of the nucleus using a chopper. In the first case (Divide and Conquer), a deep furrow is made in the central part of the lens nucleus. The second technique (Phaco Chop - fracture of the lens nucleus) is divided into horizontal and vertical chop. The advantages of the Divide and Conque technique are the relative ease of the operation and absence of necessity for special surgical instruments, while the disadvantages are high consumption of ultrasound (US) energy and long operation time. At the same time, the benefits of Phaco Chop are as follows: US energy saving and reduction of surgical time. Of course, this technique also has disadvantages – more complicated technique and the need for additional surgical instruments.

The correct fracture of the lens nucleus is important and contributes to the decrease of the ultrasound energy amount, to reduce the risk of rupture of the posterior capsule and iris damage. Reduction of US energy amount is well known to help preserve corneal endothelial cells. Aside from the exposure time and US type, the loss of endothelial cells is also caused by the contact of the lens masses with corneal endothelium, turbulence and intensity of the irrigation fluid flow, the occurrence of free radicals, heating and burn of the corneal tunnel [1-8].

Thus, the improvement of the existing techniques to fracture the lens nucleus in FE is an actual task.

**Purpose** – to develop a technique to fracture the lens nucleus during cataract phacoemulsification to reduce the energy load of ultrasound and complications.

**Material and methods**

The study of the proposed method was carried out on 58 patients (58 eyes) of the main (1) group, who underwent the improved FE (iFE), and 56 patients (56 eyes) - the control group (2) with standard FE (phacochop). The compared groups were comparable in age (on average 69,92±6,21 and 70,22±7,08 years, respectively) and gender (male 27 and 24, female 31 and 32), as well as the nature and frequency of concomitant pathology. In particular, 8 patients of the main group and 7 of the control group had antiglaucoma operations. In group 1, moderate destruction of the vitreous body was observed in 36,2% of cases, and in the comparison group it was observed in 35,7%. In addition, 8.6% and 8,9% of patients, respectively, underwent restrictive retinal laser photocoagulation due to diabetic retinopathy. FE was performed not earlier than 6 months after other operations.

Lens subluxation of the 1-st and 2-nd degrees according to N.P. Pashtaev was diagnosed in 17,2% of cases in the main group and in 16.1% of the control group. Cataract density according to L. Buratto of II-III degree in the 1-st group was observed in 45,5% of cases, of degree IV - in 53,5%, and in the 2-nd group - in 46,4% and 53,6%, respectively.

The improved FE was carried out according to the method proposed by us (RF Patent No. 2331398), the essence of which is that the phaco-needle was immersed up to the anterior pole of the lens, after which occlusion was created. The outer layers of the lens were put aside by spatula, the central part of the nucleus, 3–4 mm in size, was isolated and broken off and emulsified. The tip was brought to the edge of the remaining part of the lens, occlusion was created and, pulling it to the center, the fragment was separated with a spatula and emulsified. To remove the next sector, if necessary, the lens was rotated.

The phacoemulsification system Infiniti (Alcon) was used during the operation, using torsion US, which made an incision in the lens substance by vibrating the needle across the body (from side to side). All patients underwent a comprehensive ophthalmological examination.

Statistical data processing was carried out using the STATISTICA 6.1 program. Group indicators of summary statistics were calculated - the arithmetic mean (M) and mean error (m). Differences were considered statistically significant at $p<0.05$.

Table 1

**Technical characteristics of FE parameters in the compared groups (M ± m)**

| index | Group 1 (n = 58, aFE) | Group 2 (n = 56, FE) |
|---|---|---|
| Total ultrasound time (sec.) | 79,84±13,94* | 130,89±16,91* |
| Longitudinal ultrasound (sec.) | 11,13±3,55 | 12,56±4,82 |
| Torsion ultrasound (sec.) | 86,12±13,14* | 129,07±15,38* |
| Aspiration time (sec.) | 195,51±22,18* | 264,21±26,87* |
| Spent cumulative energy (kJ) | 21,44±4,48 | 29,78±4,96 |
| Equivalent power (%) | 18,76±2,75 | 20,25±3,03 |
| The total amount of fluid spent (ml) | 59,73±7,07 | 67,71±8,32 |
| FE time (sec.) | 1098,73±115,34 | 1203,42±123,36 |

*Note: *The difference between groups is statistically significant, $p \leq 0.05$*

**Results and discussion**

Postoperatively there were no complications, and the planned IOL models were implanted in patients. The technical parameters of FE were chosen depending on the cataract density. The ultrasonic and hydrodynamic characteristics of FE in the studied groups are presented in the table 1.

From the table, it is seen that ultrasonic and hydrodynamic intra-operative parameters in the 1st group were lower and statistically significantly differed from the data of the 2nd group. Thus, the time of the general US in the aFE group reduced by an average of 39,0% compared to the standard FE; the time of the torsion US – by 33,3%, the aspiration time - by 26,1%. Also in the 1st group there was a tendency to reduce the values of total energy by 28,0%.

Analysis of complications (corneal edema, posterior capsule defect, IOL dislocation, etc.) observed during and after the operation, showed that they occurred 1,5 times less in comparison with the standard technique (6,1% and 9, 2%, respectively).

Data of refractometry and ophthalmometry in the compared groups at different times after operation indicate that in the 1st (main) group the spherical component of refraction statistically significantly differed from the initial data on the 2nd day (-0,38 ± 0.09 versus -0,65 ± 0.1) post-operatively and 3 months (-0,12 ± 0,06 versus -0,32 ± 0,07) post-operatively ($p \leq 0,05$). The spherical component of refraction in the 1st (main) group did not change statistically significantly after 6 months and 1 year post-operatively in relation to data after 3 months post-operatively. In the main group, the cylindrical component of refraction has not changed significantly post-operatively in relation to initial data, at the same time there was observed tendency in a change of the cylindrical component of refraction after 3 months in relation to postoperative data on the 2-nd day. However, there were not observed statistically significant changes in the cylindrical component in the 1-st group. There were no differences in the spherical and cylindrical components during the period of 6-12 months.

The average values of not-corrected visual acuity (NCVA) and maximum corrected visual acuity (MCVA) are represented by decimal measurement system, and lower – by LogMAR. In order to correctly calculate the average visual acuity, the geometric average was used in LogMAR according to the Bailey and Lovie table (Bailey, Lovie, 1976), which is the most accurate method.

The data of not-corrected visual acuity (NCVA) and maximum corrected visual acuity (MCVA) checked on the 2nd day post-operatively increased statistically significantly and expectedly considerably; and differed from the initial, pre-operative data ($p \leq 0,05$). In the long-term follow-up period (3-6 months), in both groups, MCVA and MCVA data have been improving gradually and were stable up to a year. On the 2nd day post-operatively NCVA was statistically significantly ($p \leq 0,05$) higher by an average of 0,14 ± 0,06 and MCVA – by 0,12 ± 0,09 in the main group compared to the data of the control group.

The statistic difference ($p \leq 0.05$) between the average values of intraocular pressure (IOP) in groups was observed only on the 2nd day post-operatively (16,32 ±2,18 versus 23,1±1,98). We associate this fact with transient ophthalmohypertension after the phacoemulsification of dense nuclei, which was stopped by the instillation of antihypertensive drugs. During follow-up period, there was no statistic difference between the average IOP values in groups and between groups.

The density indicators of endothelial cells changed in both groups post-operatively: cells density in the 1st group decreased after 1 month by 136,42 ± 23,65 (5,8%) cells/mm2 and after 3 months for 154,49 ± 25,31 cells/ mm2 (6,6%); in the 2nd group, the density of the endothelial cells decreased by 188,51 ± 31,22 (7,8%) and by 172,22 ± 34,88 cells (7,1%), respectively, in relation to pre –operative data; but the difference was not statistically significant.

After 1 year, data of cells changes of the corneal posterior epithelium (CPE) in the 1st group were reduced by 177,14 ± 24,51 (7,51%) cells/mm2; in the 2-nd group – by 206.64 ± 30.83 (8.6%) cell/mm2 in relation to initial data. Comparative analysis revealed the fact that density of endothelial cells after 1 month postoperatively in the 2nd group was lower by 2.0 % in comparison with the 1-st group; the difference was not reliable. It should be noted that there was no statistically significant difference in CPE data in studied groups during post-operative follow-up period.

In both groups, on the 2-nd day pos-operatively, according to optical coherent tomography (OCT), the thickness of the cornea in the center statistically significantly differed from the initial parameter, but this parameter increased more noticeably following the standard FE (from 540,71 ± 22,92 to 658,85 ± 29,11) than after its improved version (from 537,.64 ± 24,18 to 577,26 ± 28,31) (p <0,05), this fact being associated with corneal edema.

**Conclusion**

The proposed technique of lens nucleus fracture during FE helps to reduce the total time of US energy load on eye organs by an average of 39.0%; and the time of torsion US – by 33.3%; the time of aspiration - by 26.1%; and also helps to reduce intra- and post-operative complications by 1.5 times compared to standard technique (6.1% and 9.2%, respectively).

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