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CLINICAL STUDY

The impact of phacoemulsification cataract surgery on eyes previously treated by laser photocoagulation for diabetic retinopathy

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Abstract: *Aim of study:* to evaluate the evolution of diabetic retinopathy (DR) after cataract surgery on eyes previously treated by photocoagulation for DR. The compensation of glycaemia (glycosylated haemoglobin, HbA1c) and prevalence of attendant diseases (hypertension, ischemic heart disease and alteration of lipid metabolisms) were evaluated.
Methods: Forty eyes (40 patients) were evaluated, of which ten (25 %) eyes with DR were treated without laser photocoagulation (LK), and 30 (75 %) eyes were previously treated by LK. Two criteria for evaluating the stabilisation were used, particularly the best corrected visual acuity (BCVA) and the necessity of additional laser photocoagulation.
Results: As many as 100 % of eyes without LK and 86.7 % of eyes with LK had BCVA improved on the first day after surgery ($p \leq 0.05$). The BCVA of 0.5 or better was achieved in 31 eyes (77.5 %). The mean level of HbA1c in group without LK was 7.09±1.21 %; in group after LK it was 7.36±1.64 %. The mean level of HbA1c in the group with stable BCVA was 7.14±0.46 % and the duration of DM was 18.6±2.93 years. HbA1c, in group of eyes with worsened BCVA, was 7.86±2.23 %, and the duration of DM was 21.0±8.54 years. HbA1c in the group of stable eyes (without LK after surgery) was 6.71±0.1 %, and the duration of DM was 17.84±8.97 years. HbA1c, in group, where additional LK was applied, was 7.56±0.69 %, and the duration of DM was 19.54±3.26 years. The difference in levels of HbA1c was statistically significant ($p \leq 0.1$). The prevalence of attendant disease was highest in the group of eyes with worsened BCVA and necessity of additional LK.
Conclusion: The results of study confirm an improvement in BCVA after cataract surgery by phacoemulsification in the most of patients. Better stabilisation of glycaemia levels and lower frequency of internal diseases were in group with stable BCVA and without necessity of additional LK after cataract surgery *(Tab. 3, Fig. 1, Ref. 28)*. Full Text in PDF *www.elis.sk.*
Key words: diabetic retinopathy, phacoemulsification, HbA1c, hypertension, coronary ischaemic disease, alteration in lipid metabolisms.

The study investigates the development of diabetic retinopathy (DR) after *phacoemulsification* cataract surgery on eyes previously treated with photocoagulation for DR. The compensation of glycaemia (based on the level of glycosylated haemoglobin), and prevalence of attendant diseases (hypertension, coronary ischaemic disease and alteration of lipid metabolisms) were evaluated.

Diabetes mellitus (DM) is one of the mostly extended diseases in the world and the number of people suffering from DM is growing permanently. This evolution has repercussions on population's morbidity and mortality. The risk of diabetic retinopathy (DR) and cataract increases with duration of disease (16, 23). The benefit of laser photocoagulation (LK) on course of DR and diabetic maculopathy was presented in various studies (6, 19, 1, 18, 12). The number of patients treated by LK is growing. Patients with DM develop cataract earlier and more frequently. Cataract surgery is made also on eyes previously treated by LK. The influence of cataract surgery on DR was documented in several studies (5, 8, 10, 14). Some of the studies had documented the progression of DR after cataract surgery. Macular oedema pre-existing before surgery or advancing after operation, neovascular glaucoma and vitreous haemorrhages deteriorate the vision. (14). The progression of DR depends also on other factors such as age, duration of DM, but mostly on longstanding compensation of glycaemia, prevalence of hypertension and alteration in lipid metabolisms.

The aim of study was to evaluate the stabilisation of DR in eyes after cataract surgery based on changes in best corrected visual acuity (BCVA) and necessity of additional LK. The retinal treatment was based on comparing fluorescein angiography (FA) before and in week 5 after cataract surgery. The relations of progression of DR to glycaemia control (based on level of HbA1c), prevalence of hypertension and duration of DM were provided in this study.

Methods

A group of 40 patients (40 eyes) with cataract surgery performed at the Ophthalmology Ward, St. Lucas Hospital Galanta, from March 2008 to October 2010, were evaluated in a prospective

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study. The study was confirmed by the Hospital Ethic Committee, and the informed agreement was obtained from each patient.

The ophthalmologic examination (BCVA measured on Snellen´s optotypes, intraocular pressure, and biomicroscopic investigation of the anterior segment and retina) was done before surgery. Fluorescein angiography with use of 10% natrium fluorescein intravenously was done 5 days before surgery on Canon fundus camera. The assessment of angiograms was done from positive black-and-white film. Blood level of HBA1c was obtained on the day of cataract surgery. Information about general health status was collected from internal preoperative examination (hypertension, coronary ischaemic disease (CID), and alteration in lipid metabolisms (AML).

The cataract surgery was performed under local anaesthesia by applying drops of oxybuprocain hydrochloricum 0.4 %. The phacoemulsification was used in all procedures with corneal incision 2.75 mm and 2 paracenthesis 1.0 mm. The capsulorhexis was created by needle 25 G with use of viscoelastic material. The intraocular lenses were implanted to the capsular bag. Cefuroxim 0.ml/1 mg was injected to the anterior chamber at the end of surgery. Combination of antibiotics and corticosteroid was placated to the conjunctival sack (tobramycín 3 mg/ml + dexamethason 1 mg/ml). Diclofenacum natricum 0.1 % was dropped into 16 eyes (40 %).

BCVA and complete ophthalmologic examination, same as before surgery, was investigated on day 1 after surgery, then after 2 weeks, and later, 3, 6, 9 and 12 months after cataract surgery. The fluorescein angiography was made in week 5 after cataract surgery again. The additional photocoagulation was done according to FAG 3 months after surgery.

In vitro test on biochemical analysator Roche was used for the analysis of HBA1c level in full blood. The result is expressed as percentage of HBA1c from total amount of haemoglobin.

Two criteria were used to assess the stabilisation of diabetic retinopathy in this study as follows:

1. BCVA:

– *stabilisation* – the change in BCVA – 1 line of Snellen´s optotypes,

– *worsening or improving* - BCVA - change in more than 2 lines of Snellen's optotypes,

2. Photocoagulation:

– *stabilisation* – without additional LK after cataract surgery,

– *worsening* – additional LK guided by FAG made in week 5 after the cataract surgery.

Statistical analysis

ANOVA – statistical analysis of variation and t-test for comparison of conformity for two mean values were used in this study (Fig. 1).

Results

A group of 40 eyes (40 patients) was evaluated in this study. The characteristics of group are in Table 1.

Ten eyes (25 %) with DR have not been treated with LK. Thirty eyes (75 %) have been previously treated with LK for DR (8 eyes had non-proliferative DR (NPDR) with clinically significant macular oedema (CSME), 6 eyes had advanced NPDR with diffuse diabetic macular oedema (DME), 9 eyes had advanced NPDR with CSME, 3 eyes had proliferative DR (PDR) with non-significant DME, and 4 eyes had h PDR with CSME).

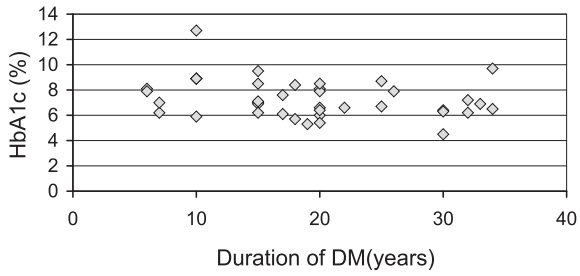

Fig. 1. The comparison of levels of HbA1c and years of duration of diabetes mellitus.

Thirty eyes were divided to subgroups according the type of LK as follows: 8 (2.7 %) were after focal treatment of DME; 12 eye (40 %) were after panretinal photocoagulation (PRP) and focal treatment of DME; 10 eyes (33.3 %) were treated by grid photocoagulation combined with PRP.

Worsened BCVA was the indication for cataract surgery in 34 eyes (85 %), impossibility to continue with LK 4x (10 %) and planed pars plana vitrectomy in 2 eyes (5 %). Table 2 shows mean BCVA before and after cataract surgery.

On the first day after cataract surgery, BCVS improved in 10 eyes (100 %) in the group without LK. Twenty-six eyes (86.7 %) in group after LK had better BCVA after surgery. These changes are statistically significant ($p \leq 0.05$) in both groups.

BCVA of 0.5 or better was in 31 eyes (77.5 %) of the whole group, BCVA of less than 0.5 (1x anterior ischemic optic neuropathy, 7x advanced DME) was in 8 eyes. BCVA was evaluated 5 weeks after cataract surgery. Ten (100 %) eyes were stabilised in group without LK. Four eyes (13.3 %) in group after LK improved,

Tab. 1. Clinical characteristics of patients (eyes) without and after lasercoagulation (LK) propter DR and DME with cataract surgery.

	Without LK n=10 (25%)	After LK n=30 (75%)
Mean age (SD) (range) [years]	68 (9.56) (52–79)	66.53 (8.84) (51–84)
Mean duration of DM (SD) (range) [years]	15.5 (7.40) (6–30)	19.928 (8.42) (6–34)
HbA1c (SD) (range) [%]	7.09 (1.21) (5.3–8.9)	7.361 (1.63) (4.5–12.7)
	N of patients(%)	N of patients (%)
Male/female	2(20) /8 (80)	12(40) / 18(60)
Management of DM		
Diet	0	0
Oral agents	5 (50)	8 (26,7)
Insulin	5 (50)	22(73.3)
Vascular disease		
Hypertension	8 (80)	24 (80)
Coronar ischemic disease	6(60)	19 (63.3)
Alteration of lipid metab.	3 (30)	11(36.6)
The amputation of leg	1 (10)	6 (20)

Tab. 2. BCVA patients before and after cataracts surgery in the different group of eyes according type of DR.

BCVA	Without LK	Non- prolif. DR with CSME	Non- prolif. DR with dif. DEM	Advanced NPDR with s CSME	PDR with non signif. DME	PDR with CSME	After LK
	N=10	N=8	N=6	N=9	N=3	N=4	N=30
Before surgery							
Average BCVA	0.28	0.35	0.12	0.44	0.33	0.38	0.34
SD	0.18	0.25	0.09	0.14	0.28	0.31	0.23
1thday after S							
N	10	8	6	9	3	4	30
Average BVCA	0.73	0.74	0.35	0.75	0.75	0.81	0.67
SD	0.28	0.21	0.27	0.32	0.21	0.15	0.3
5 th week							
N	10	8	6	9	3	4	30
Average BCVA	0.74	0,76	0.32	0.76	0.87	0.81	0.69
SD	0.31	0.20	0.30	0.28	0.12	0.15	0.30
3 th month							
N	10	8	6	9	3	4	30
Average BCVA	0.70	0,´.76	0.31	0.69	0.8	0.44	0.6
SD	0.34	0.13	0.31	0.39	0	0.42	0.33
6th month							
N	7	5	6	7	2	4	24
Average BCVA	0.8	0.69	0.32	0.62	0.72	0.45	0.53
SD	0.32	0.18	0.31	0.37	0.12	0.41	0.33
9 th month							
N	7	3	5	7	2	3	20
Average BCVA	070	0.67	0.23	0.60	0.72	0.68	0.54
SD	0,.2	0.23	0.18	0.4	0.12	0.30	0.33
1 year after S							
N.	5	3	5	5	2	3	18
Average BCVA	0.78	0.59	0.20	0.76	0.72	0.75	0.5
SD	0.4	0.37	0.18	0.22	0.12	0.21	0.2
NX							
N(%)	10 (100)	8 (100)	5(83.3)	9 (100)	3(100)	4 (100)	29 (96.6)
NY							
N(%)	9 (90)	8 (100)	5 (83.3)	7 (77.7)	3 (100)	2 (50)	25 (83.3)

LK – lasercoagulation, CSME – clinically significant macular oedema, DR – diabetic retinopathy, NPDR – non-proliferative diabetic retinopathy, DME – diabetic macular edema, N – number of eyes in group, S – cataract surgery, NX – number of stabilisated eyes 5 th week after cataract surgery, NY – number of stabilised eyes 3 th month after cataract surgery

Tab. 3. Comparison of mean age, duration of DM HbA1c and the internal diseases at the group of stabilised and worsened eyes.

	Stabilised BCVA N (%) 33 (82.5)	Stabilised eyes (without LK) N (%) 14 (35)	Worsened BCVA N(%) 7 (13.3)	Worsened eyes (LK after surgery) N (%) 26 (65)
Mean* duration of DM	18.61	17.86	21.0	19.54
(SD)	(±2.93)	(±5.18)	(±8.54)	(±3.26)
range [years]	15.68–21.54	12.68–23,04	12.46–29.54	16.28–22.80
HbA1c mean *	7.14	6.71	7.86	7.56
(SD)	(±0.46)	(±0,57)	(±2.23)	(±0.69)
range [%]	6.67–7.60	6.14–7.29	5.63–10.09	6.87–8.25
	N (%)	N (%)	N (%)	N (%)
	33(100)	14(100)	7(100)	26(100)
The internal disease				
Hypertension				
Cardial ischemia	27(81.82)	9(64.30)	6(85)	25(96.15)
Alteration of lipid metab.	22(66.67)	7(50.0)	3(42.85)	18(69.23)
	16(48.49)	4(28.57)	1(14.285)	11(42.30)

*mean 95% confidence interval

25 eyes (83.3 %) became stable and 1 eye (3.4 %) got worse. The next examination of BCVA was 3 months after cataract surgery. Ninety percent of eyes in group without LK and 83.4 % of eyes in group with LK were stabilised.

Six months after cataract surgery, 85.7 % of eyes in group without LK and 75 % of eyes in group after LK were stabilised. The differences in BCVA during evaluation were not statistically significant ($p \geq 0.05$). Four eyes (40 %) in group without LK and

18 eyes (60 %) were stabilised (without necessity of additional LK) 3 months after cataract surgery. The additional LK was done according to FAG 5 weeks after cataract surgery.

Mean value of HbA1c in the entire group was 7.23 % and mean duration of DM was 17.71 years. The lower value of HbA1c was established in group of eyes stabilised according to BCVA (7.07 %). Mean value of HbA1c in group with worsened BCVA was 11.07% and mean duration of DM was 23.8 years. These differences were not statistically significant ($p \geq 0.05$). Mean values of HbA1c in groups without and with additional LK were 6.986 % and 7.53 %, respectively. This difference was statistically significant for $\alpha = 0.1$.

The mean duration of DM in group with stabilised BCVA was 18.61±2.90 years, group with worsened BCVA was 21.0±8.54 years. These differences were not statistically significant ($p \geq 0.05$).

Mean duration of DM in group without additional LK was 17.86±5.18 years. Mean duration of DM with necessity of additional LK was 19.54±3.26 years. This difference was not statistically significant ($p \geq 0.05$).

Graph 1 represents the relation between the value of HbA1c and duration of DM. The indirect straight dependence is between the duration of DM and value of HbA1c (coefficient of correlation is -0.1993, $p = 0.5809$).

The prevalence of internal diseases was evaluated in the study.

Table 3 shows the prevalence of hypertension, cardiac ischaemic disease and alteration in lipid metabolisms in different groups of eyes divided according to the criterion of stabilisation.

Discussion

In diabetic patients, the cataract develops earlier and its prevalence is more frequent. The indication for cataract surgery occurs not only when BCVA gets worse, but also when the examination of the retina becomes impossible or when it is impossible to continue with photocoagulation. The earlier indication for cataract surgery is still more frequent to prevent the advancement of the condition when the retina cannot be examined. (28) A different study evaluated the course of diabetic retinopathy previously treated with LK after cataract surgery (2, 4, 7, 8, 11, 17, 22).

It is appropriate to perform laser coagulation 3 weeks to 3 months before surgery (17, 28). The patient's visual acuity after cataract surgery depends on the magnitude of DR, photocoagulation before surgery and transparency of optic media. Some studies attribute the worsening of DME to cataract surgery. Other studies consider this worsening of DME to be a natural course of disease (2, 11)

The improvement in BCVA in our study was present in the majority of patients. DME worsened the BCVA in 7 cases (17.5 %). Flesner et al had similar results, particularly the visual acuity in their study improved in 36 of 39 eyes. Similarly to our study, DME worsened the BCVA. (7).

Three months after surgery, BCVA became stable in 33 eyes (82.0 %) of the whole tested group. In the groups without and after LK, the stability of BCVA was achieved in 9 eyes (90 %) and 26 eyes (86.7 %), respectively.

Up to 60 % of eyes had progression of DR and DME, and additional LK was done 3 months after cataract surgery. Pollack et al. observed progression of DR in 38% of eyes without LK and in 39 % after LK. They were assessed as a progression of significant aggravation of DR with a development of cystoid macular oedema or as a change in proliferative DR (21). In our study, the criterion used for evaluating the progression was stronger (every additional LK). This is the probable cause of the differences in results. The EDTRS study had better results probably as a result of intensive photocoagulation (5).

In our study, the cataract surgery was made by phacoemulsification, which has a better prognosis for visual acuity than extracapsular cataract extraction. Dowler et al. confirm the safety of phacoemulsification as well as a better prognosis after the procedure. The most important factor of success of cataract surgery is the state of retina in the macular region (3).

The complications of cataract surgery include DME progression, development of rubeosis iridis, progression of macular ischemia, haemophtalmus, fibrin reaction and rapid development of posterior capsular opacification (28). We did not observe any complications 3 months after cataract surgery. The development of proliferative DR was observed in one patient 9 months after surgery when the general state of patient rapidly worsened.

The HbA1c is the most important parameter of long-term compensation of DM in last 8 weeks. The value of more than 7.5 % (7 mmol/l) increases the risk of microvascular complications (20). The risk of complications in DM type 2 is linked independently and additionally to hyperglycaemia and hypertension. In order to reduce the ratio of complications it is necessary to treat these risk factors intensively (25).

We observed higher values of HbA1c in the worsened group of patients evaluated according to both criteria, but it was statistically significant only according the criterion of additional LK.

The importance of intensive control of glycaemia and blood pressure was documented in various studies (9, 13, 15, 24, 26). Ip et al established hypertension in 81 % of patients, alteration of lipid metabolism in 67 % and the mean HbA1c value in 7.9±1.8 % (13). Flesner et al found the value of HbA1c in 8.6 % of the tested group of complicated patients and in 8.3% of patients with no complications. The value of HbA1c was higher in group of patients with progression of DME (8). Despite this finding, Henricsson et al. did not confirm glycaemia control to be the factor of progression of DR. (10)

Good control of hypertension in diabetes of type 2 is important for diminishing the risk of death in relation to DM and reducing the rate of complications (progression of DR and worsening of BCVA (27).

The prevalence of hypertension, ICHS and alteration in lipid metabolism was highest in the worsened group, where eyes needed additional lasercoagulation after surgery. The mean duration of DM was shorter in group of unstable patients.

Flesner et al documented that 80 % of patients were treated with antihypertensive therapy in group of complicated patients, and 72 % of patients were treated in their uncomplicated group. The authors do not consider the grade of DR and general health status

to be a significant factor of risk of progression of DR after cataract surgery if the photocoagulation is completed before surgery (8).

Conclusion

Results of our study confirm that diabetic retinopathy treated by photocoagulation can be stabilized also after cataract surgery. BCVA stays stable for long time after the cataract surgery if the retina is stabilised in the macular region. The risk of worsening the BCVA increased when the additional LK was needed after cataract surgery. The additional LK was needed in patients with poor control of glycaemia. Intensive monitoring, correction of glycaemia with help of HbA1c, examination and treatment of risk disease (hypertension, coronary ischaemic disease and alteration in lipid metabolism) can delay the progression of diabetic retinopathy.

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