Incidence of Glaucoma in Ocular Hypertension patients post laser-assisted in situ keratomileusis (LASIK) treatment

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Objective: To report the incidence of optic nerve damage in patients with ocular hypertension (OHT) 4 years after LASIK treatment and to study the relationship of transient IOP rises during LASIK treatment to optic nerve damage and to determine potential risk factors for glaucoma progression in OHT patients after LASIK treatment.
Design: cohort retrospective study
Methods: A cohort retrospective study review of 139 patients with OHT who underwent LASIK surgery at BMA hospital was performed from 2008 – 2012. All patients were followed up for optic nerve damage for 4 years. Glaucoma progression was determined by using CTVF and OCT. Cox proportional hazard model was used to determine potential risk factors such as age, IOP, CCT and VCD ratio.
Results: Among 139 patients, 6 eyes of 6 patients (4.3%) developed POAG (95%CI: 09% to 7.7%), the incidence rate of POAG at 4 years was 2.9%. No glaucoma progression was found at 1 year after LASIK treatment. Age and IOP were significant risk factors for the development of glaucoma, (HR= 1.12, 1.91; $p = 0.038, 0.025$) respectively.
Conclusion: The incidence of patients who developed POAG after LASIK at 4 years was low (4.3%) compared to the OHTS group at 5 years (9.5%, non-treatment group). LASIK does not increase the risk of OHT patients in developing glaucoma. Brief rises in IOP during Keratomileusis did not damage the optic nerve. Age and IOP play the important roles in glaucoma progression for OHT patients.
Conflicts of interest: None
Keywords: Ocular Hypertension, LASIK, Glaucoma

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Introduction

Glaucoma is a leading cause of irreversible blindness throughout the world. The ocular hypertension patients (OHT) have greater risks to develop glaucoma. The myopic patients also have high incidence of OHT,

some of them consider LASIK for myopic correction. Ocular Hypertension study groups (OHTS) show conversion from OHT to POAG was 9.5% in the untreated group.[1]

We observed the incidence of myopic patients who had OHT converse to POAG after LASIK treatment. The risk of optic nerve damage and VF change after LASIK procedure are still controversy in those with OHT. This study will help us to answer the question: Is it safe enough to do LASIK to OHT patients? The brief increase in IOP to 60-90 mmHg during the application of the suction ring may increase optic nerve damage.[2,3,4,5,6] Keratorefractive surgery changes the central cornea thickness (CCT) and cornea curvature which could influence the IOP measurement by Goldmann applanation tonometry (GAT) technique that may make unreliable IOP follow up after LASIK.[7] The standard computerized visual field (CTVF) and optical coherence tomography (OCT) may play an important role in early diagnosis and follow up patients who have risks after LASIK.[10,11,12,13]

Methods

The 139 myopic patients who diagnosed OHT and undergone LASIK surgery at BMA Hospital from 2008 to 2012. All of the patients have glaucoma examination and follow up for glaucoma progression by single glaucoma specialist. This study defines OHT by IOP between 21 mmHg and 32 mmHg in both eye, gonioscopically open angles, normal visual field test and OCT. The IOP was measured with GAT and used the computerized visual field (program 30-2) test and OCT RNFL to evaluate the glaucoma progression in follow up period at 1, 3, 6 months and every year. The vertical cup to disc ratio was measured by using non-contact lens 90D under a slit lamp biomicroscope. All of patients have to follow up for at least 4 years. Patients who can't follow up for at least 4 years will exclude from this study. We used Anderson-Patella's criteria and neuroretinal rim thinning from OCT RNFL report. These must show the same area correlate with VF changed. Criteria for diagnosis glaucoma is positive finding on VF and OCT in same area for 2 consecutive follow ups. The incidence of glaucoma is collected when the patient had glaucomatous disc change or positive in CTVF and/or OCT test in one or both eyes. Criteria for diagnosis ON damage after Keratomileusis is the patient has optic nerve damaged correlated with retinal nerve fiber layer damage within 1 year after surgery.

Statistic analysis

Demographic data was presented by descriptive statistic. Categorical data was presented by percentage and continuous data was presented by mean and standard deviation (SD).

Cox proportional hazard analysis was used to identify the risk factors related to glaucoma progression. All statistics were two-tailed and performed at the 0.05 significance level.

Results

A total of 139 patients were observed in our study. The demographic data is shown in Table 1. All patients are Thai, mean age was 33.93±6.99 years old. Mean age of glaucoma group was 42±5.1 years old and 33.56±6.85 years old for the non glaucoma group, 68 patients(48.92%) were male and 71 patients(51.08%) were female. Mean CCT was 535.55±27.91 micron. Mean CCT of glaucoma group was 527±14 micron and 535.94±28.34 micron for non glaucoma group.

Mean IOP was 23.21±1.55 mmHg. Mean IOP of glaucoma group was 25±2.02 mmHg and 23.12±1.48 mmHg for non glaucoma group. Mean C:D ratio was 0.40±0.11. Mean C:D ratio of glaucoma

group was 0.7±0.7 and 0.38±0.8 for non glaucoma group. The follow up period was at least for 4 years. Among those patients, 6 eyes from 6 patients (4.3%, 95%CI: 0.9% to 7.7%) show glaucoma progression by VF analysis and OCT. Incidence of POAG at 4 years after LASIK was 2.9%. There were no patients who were diagnosed for glaucoma within 1 year after LASIK.

Table 2 shows univariate and multivariate risk factors. Age (HR = 1.12, p= 0.038) and IOP (HR = 1.91, p = 0.025) were statistically significant for glaucoma progression. CCT (HR = 1.44, p = 0.682) was not statistically significant risk for glaucoma progression.

Discussion

LASIK surgery has become the main treatment for myopia for a decade. An increase number of patients are expected to do LASIK surgery in the future. Among those patients with OHT are still controversies that they could do LASIK surgery. There are also some concerns about IOP measurements before and after surgery. As all IOP measurements were done by GAT and it depends on CCT that the cornea thinner and flatter after LASIK surgery can expected to lower than actual IOP. Low IOP measurement by GAT after myopic laser surgery has been reported in many studies.[7,8,9] Optic nerve damage in glaucoma have specific pattern such as nasal step or arcuate. We use CT-VF(30-2) and OCT to detect glaucoma progression by functional and anatomical. Both methods are currently standard tools for detecting early glaucoma progression and useful in post-LASIK patients. In OHTS show the ocular hypertension are progressed to glaucoma in 5 years about 9.5% in the non-treatment group.[1] The incidence of POAG in our study was 4.3% at 4 years. We can use this information for LASIK patients who want to undergo for surgery that LASIK didn't play a role increase risk for glaucoma progression. There was no VF damaged 1 year after LASIK surgery so brief increase in IOP during Keratomileusis didn't increase the chance for damage optic nerve. The brief increase IOP during microkeratome procedure was reported optic nerve damage in some study[3,4] but our study didn't significant in optic nerve damage. At present, the Femtosecond lasers are commonly replaced to the standard microkeratome, IOP increase during the suction ring applied was minimal compare to microkeratome. In the future, decrease use in microkeratome will be replaced by Femtolaser so concern about damaging to optic nerve fiber should be less.

Our study we perform, Cox proportional hazard analysis to identify the risk factors related to glaucoma progression. There are many studies had reported aging, IOP, CCT are risk factors for glaucoma.[1,4,5,6] This study also showed that age and IOP were significant risk factors for glaucoma progression. In univariate analysis age, IOP were significant risk factors but CCT significant in multivariate. CCT thinner than average CCT was strong risk factor in OHTS.[1] GAT can read low IOP in thin CCT and high IOP in thick CCT. If the patients have thin CCT with high IOP, they have high risks to develop glaucoma. In summary, OHT patients didn't progress to POAG after LASIK more than OHTS. Those OHT patients can do LASIK surgery with safe and can follow up by OCT and VF as usual.

Conclusion

LASIK does not increase the risk of OHT patients to developing glaucoma. Brief increase IOP during Keratomileusis didn't damage optic nerve. Age and IOP play role in glaucoma progression for OHT patients.

Table 1: Demographic and clinical data of our patients

PARAMETERS	All (n= 139)	Non-Glaucoma (n = 133)	Glaucoma (n = 6)
Age (years)	33.93 ± 6.99	33.56 ± 6.85	42 ± 5.1
Sex (male/female)	68/71	66/67	2/4
IOP (mmHg)	23.21 ± 1.55	23.12 ± 1.48	25 ± 2.02
CCT (micron)	535.55 ± 27.91	535.94 ± 28.34	527 ± 14
C/D ratio	0.4 ± 0.11	0.38 ± 0.8	0.7 ± 0.7

IOP indicates intraocular pressure; CCT Central cornea thickness; C/D cup to disc ratio

Table 2: Univariate and Multivariate COX Proportional hazard

Analysis	HR	95% CI	*p*-Value
Univariate			
Age (Years)	1.14	1.04 - 1.25	0.006
IOP (mmHg)	2.30	1.25 - 4.15	0.006
CCT (micron) ≤ 535	2.00	0.37-10.97	0.423
Multivariate			
AGE (Years)	1.12	1.01 - 1.25	0.038
IOP (mmHg)	1.91	1.08 - 3.36	0.025
CCT (micron) ≤ 535	1.44	0.25 - 8.22	0.682

IOP indicates intraocular pressure; CCT Central cornea thickness

Table 3: Characteristics of glaucoma patients

	Case1	Case2	Case3	Case4	Case5	Case6
Age	40	38	51	42	44	37
Sex	F	M	F	F	F	M
Side	L	L	R	R	L	L
CCT pre	503,509	542,542	520,508	520,508	528,538	541,533
CCT post	335,349	537,532	448,414	448,414	386,485	502,491
C/D Pre	0.7,0.7	0.7,0.8	0.7,0.6	0.7,0.6	0.8,0.8	0.7,0.5
C/D Glau	0.7,0.7	0.8,0.8	0.7,0.6	0.7,0.6	0.8,0.8	0.7,0.6
OCT	Inferior	Inferior	Superior	Superior	Superior	Superior
CTVF	Superior	Superior	Inferior	Inferior	Inferior	Inferior
Tn pre(R/L)	25,26	23,24	26,26	22,22	25,25	28,28
Tn 1 month	10,10	16,16	12,12	13,13	12,12	12,11
Tn 2 months	11,10	16,16	13,13	13,14	12,11	12,11
Tn 3 months	10,10	16,15	13,13	14,14	13,12	13,12
Tn 6 months	11,10	17,17	13,13	14,14	12,13	12,13
Tn 1 year	12,12	16,18	15,15	14,14	13,13	13,13

Table 3: Characteristics of glaucoma patients (Continue)

	Case1	Case2	Case3	Case4	Case5	Case6
Tn 2 years	14,14	17,18	14,15	14,14	14,14	14,14
Tn 3 years	14,14	18,18	16,16	14,14	13,15	14,12
Tn 4 years	14,15	18,18	16,16	14,14	14,16	13,12
Diagnosis	3rd	4th	4th	4th	4th	4th

Note: Side: Side which have glaucoma; CCT pre: CCT pre LASIK; CCT post: CCT post LASIK; C/D pre: Cup to disc ratio pre LASIK; C/D Glau: Cup to disc ration when diagnosis for glaucoma; OCT: position of neural rim thinning; CTVF: area of visual field defect; Tn: IOP measured with GAT; (R/L): Right eye and left eye; Diagnosis: What year do patients turn to glaucoma?

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