The Effect of LASIK on Timing of Cataract Surgery

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ABSTRACT

PURPOSE: To compare the age at the time of cataract surgery in patients who have undergone microkeratome-assisted LASIK versus individuals matched for axial length, cataract grade, and visual acuity with no history of refractive surgery.

METHODS: Retrospective chart review of patients who underwent cataract extraction between September 2013 and March 2015 at the Bascom Palmer Eye Institute. Patients had a history of either microkeratome-assisted LASIK or no prior ocular surgery. Corrected distance visual acuity (CDVA) before and after cataract extraction, uncorrected distance visual acuity (UDVA) before cataract extraction, gender, axial length, and cataract grade were assessed, along with age at the time of LASIK, age at the time of cataract extraction, and the time lapse between LASIK and cataract extraction.

RESULTS: Fifty eyes of 38 patients were included in the LASIK group and 155 eyes of 136 patients were included in the control group. There was no significant difference between these groups with respect to gender (P = .87), CDVA before cataract extraction (P = .11), UDVA before cataract extraction (P = .09), axial length (P = .67), and cataract grade (P = .46). Mean age at the time of cataract extraction for patients in the LASIK group and control group were 64 ± 7 and 73 ± 8 years, respectively (P < .005). Negative correlations were found between age at time of cataract extraction and axial length in the LASIK and control groups (r = -0.18, P = .20 vs r = -0.36, P =. 01, respectively).

CONCLUSIONS: Microkeratome-assisted LASIK seems to be correlated with earlier cataract extraction. Patients with a history of microkeratome-assisted LASIK underwent cataract surgery a decade sooner than patients with similar demographic and ocular characteristics.

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The creation of the LASIK flap was initially achieved using mechanical microkeratome devices. The main principle of operation was based on stabilization of the eye using a high vacuum suction ring and then passing the keratome blade to achieve a circular, meniscus-shaped thin flap.[1] The use of microkeratomes has been associated with ocular conditions such as inflammation of the anterior segment, anterior segment ischemia due to increased intraocular pressure during suction, and mechanical stress on the globe.[2,3] Moreover, previous animal studies have demonstrated that LASIK may lead to earlier cataract formation after multiple treatments.[4] It was hypothesized that the repeated exposure of laser irradiation may damage lens epithelial cells, causing anterior and posterior epinuclear opacification.[5] Further, the effect of laser irradiation (from the excimer laser) has been shown to induce biochemical modifications that stimulate photo-oxidative stress on the anterior segment and lens proteins, leading to phototoxic and potentially cataractogenic effects.[4,6]

This study assessed the influence of microkeratome-assisted LASIK on the timing of cataract extraction. Specifically, we compared the age of patients undergoing cataract extraction after microkeratome-assisted LASIK to the age of patients undergoing cataract extraction with no prior history of refractive surgery after matching patients for axial length, cataract grade, and visual acuity.

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PATIENTS AND METHODS

PATIENTS

After approval by the institutional review board of the University of Miami Miller School of Medicine and in accordance with the tenets of the Declaration of Helsinki, medical records of patients who underwent cataract extraction with posterior chamber intraocular lens implantation performed by two surgeons (KD and SY) at the Bascom Palmer Eye Institute between September 2013 and March 2015 were reviewed.

INCLUSION AND EXCLUSION CRITERIA

The patients included in this study had either previous microkeratome-assisted LASIK (LASIK group) or had an unremarkable ocular history (control group). Patients with a history of LASIK prior to 2001 were assumed to have undergone microkeratome-assisted LASIK because the first femtosecond laser platform introduced for flap creation was approved by the U.S. Food and Drug Administration in 2001. Patients undergoing LASIK after 2001 were only included if medical records were available specifically documenting microkeratome use for flap creation. Patients who had corrected distance visual acuity (CDVA) between 20/30 and 20/200 at the time of cataract evaluation and 20/20 or better after cataract extraction were included. Patients with limited visual potential (worse than 20/20 postoperative visual acuity) were excluded because their vision was limited by other ocular comorbidities.

Patients with previous ocular surgery (other than microkeratome-assisted LASIK), corneal opacities, corneal dystrophies, keratoconus, pellucid marginal degeneration, irregular astigmatism, potential cataractogenetic factors (eg, diabetes, uveitis, trauma, glaucoma, intraocular surgery, and topical or systemic steroid use), and macular disease of any type were not included in this study.

OUTCOME MEASURES

CDVA before and after cataract extraction, uncorrected distance visual acuity (UDVA) before cataract extraction, cataract grade using the Lens Opacities Classification System III (LOCS III), age at the time of LASIK, age at the time of cataract extraction, and the time lapse between the two procedures were documented. Additionally, refractive error of patients with LASIK before cataract extraction and the axial length of all patients were recorded.

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS for Windows software (version 22; SPSS, Inc., Chicago, IL). Age at the time of cataract extraction, gender, CDVA before and after cataract extraction, UDVA before cataract extraction, cataract grade (LOCS III), and axial length were compared between the two groups and correlations between axial length and age at the time of cataract extraction were assessed. Analyses included the Student's independent *t* test for continuous variables and Pearson coefficient for strength of associations. Power analysis was performed using G*Power 3.1 program (Apple Computers, Inc., Cupertino, CA)[7] to determine the sample size necessary to give statistical reliability. A *P* value less than .05 was considered statistically significant.

RESULTS

This retrospective chart review identified 760 eyes of 640 patients who underwent cataract extraction performed by two surgeons (KD and SY) between September 2013 and March 2015. From these 760 eyes, 50 eyes of 38 patients (LASIK group) and 155 eyes of 136 patients (control group) met the inclusion and exclusion criteria and were included in the study. Significant power was demonstrated for both groups (1.0).

The LASIK group included 19 women and 19 men and the control group included 66 women and 70 men. There was no statistically significant difference between groups except for age (**Table 1**). The mean time interval between LASIK and cataract extraction was 14.7 ± 3.67 years (range: 7 to 23 years). There was a positive correlation between age at the time of LASIK and age at the time of cataract extraction for patients in the LASIK group ($r = 0.88$, $P = .01$). Negative correlations were found between age at the time of cataract extraction and axial length in the LASIK group and the control group ($r = -0.18$, $P = .20$ and $r = -0.36$, $P = .01$, respectively) (**Figures 1-2**).

DISCUSSION

Corneal laser refractive surgery has been associated with cataractogenesis.[2,3,5,6,8] As demonstrated in animal models, both laser irradiation and increased suction by microkeratome devices may promote cataract development.[2,3,5,6,8] The initial assumptions on the use of argon fluoride excimer lasers in refractive surgery and the potential ocular tissue implications (aside from the cornea), such as cataract development or retinal toxicity, were supportive of no collateral tissue damage based on the fact that the lasers' maximal corneal penetration was 1 to 3 µm (no irradiation dispersion).[4] Later studies on animal models have demonstrated that part of the laser's irradiation is neither reflected nor absorbed by the cornea and is transmitted as secondary irradiation reaching the an-

TABLE 1
Characteristics Between Groups

Characteristic	Microkeratome-Assisted LASIK	No Prior Ocular Surgery	*P*
No. of eyes	50	155	–
Gender			.87
Male	19 (50%)	70 (51%)	
Female	19 (50%)	66 (49%)	
Age (y)	64.1 ± 7.2	73.0 ± 8.1	.005
AL (mm) (mean ± SD)	24.9 ± 1.56	24.8 ± 1.40	.67
Pre-CE CDVA (logMAR) (mean ± SD)	0.27 ± 0.11	0.3 ± 0.12	.11
Pre-CE UDVA (logMAR) (mean ± SD)	0.57 ± 0.29	0.66 ± 0.28	.09
Pre-CE spherical equivalent (mean ± SD)	2.03 ± 1.58	3.20 ± 3.40	.01
Cataract grade (LOCS III) (mean ± SD)	2.30 ± 0.54	2.31 ± 0.54	.46

AL = axial length; SD = standard deviation; CE = cataract extraction; CDVA = corrected distance visual acuity; UDVA = uncorrected distance visual acuity; LOCS III = Lens Opacities Classification System III

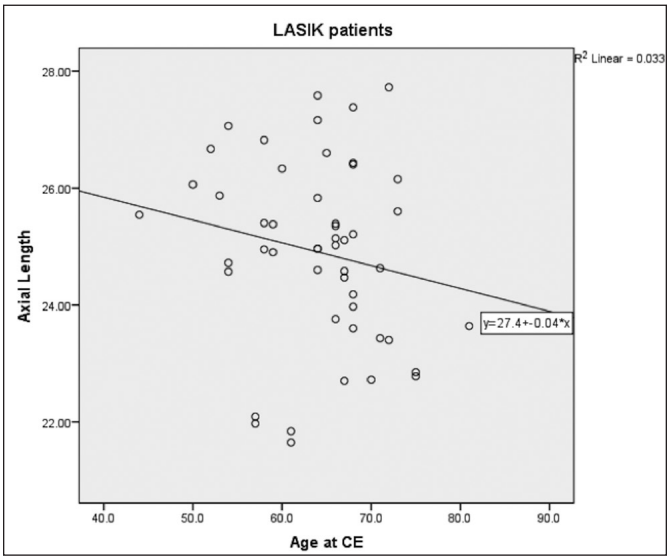

Figure 1. Correlation between age at cataract extraction (CE) and axial length in the LASIK group. Data show a nonsignificant inverse correlation between age at CE and axial length (r = -0.181, P = .209).

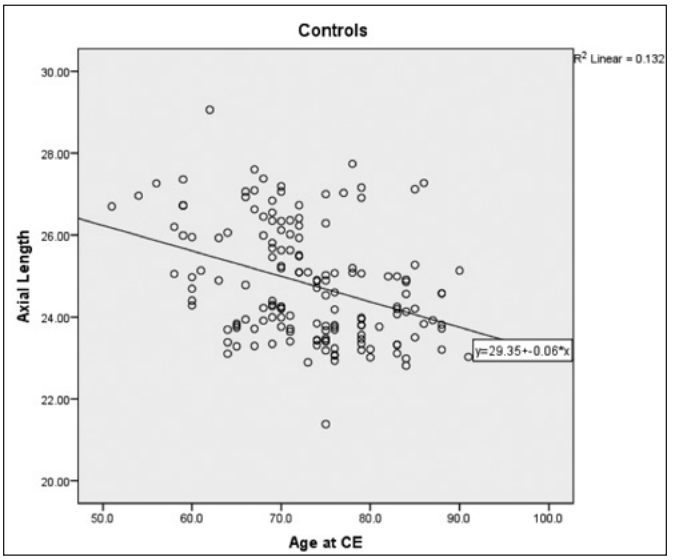

Figure 2. Correlation between age at cataract extraction (CE) and axial length in the control group. Data show a significant inverse correlation between age at CE and axial length (r = -0.363, P < .0001).

terior chamber and crystalline lens at cataractogenic wavelengths (290 to 320 nm).[8] In support of the above, other studies mention that excimer laser irradiation can stimulate photo-oxidative stress at the level of the anterior segment, resulting in phototoxic and cataractogenic effects.[5] Nevertheless, this issue remains controversial; a study by Wachtlin et al. comparing PRK and LASIK demonstrated that laser irradiation does not seem to be a risk factor for cataractogenesis because it does not promote the presence of free radicals in the aqueous humor or the crystalline lens.[9]

Microkeratome-assisted flap creation requires a stable globe to achieve repeatable, predictable, and safe outcomes. Globe stability is accomplished by the induction of high suction by microkeratome devices, and the result of this is increased intraocular pressure that reaches more than 65 mm Hg in most cases.[1] The sudden intraocular pressure increase causes ocular ischemia, as characterized by vision loss during microkeratome-assisted LASIK. When intraocular pressure exceeds retinal artery pressure, it minimizes blood flow and induces mechanical stress on the globe, resulting in contraction of the anterior segment and anterior-posterior compression with subsequent expansion of the globe.[10] Increased intraocular pressure associated with ischemic ocular stress may be

correlated with cataractogenesis because it has been shown that moderate mechanical stress may result in a localized opacity near the surface of the lens.[11]

In our study, we found that microkeratome-assisted LASIK seems to be correlated with earlier cataract extraction. Patients with a history of microkeratome-assisted LASIK demonstrate visually significant cataracts resulting in cataract extraction a decade sooner when compared to patients with similar demographic and ocular parameters. These findings are in agreement with a recent study by Iijima et al., which demonstrated a 10- to 15-year earlier cataract extraction in patients with history of LASIK when compared to a group of patients with no previous refractive surgery and matched axial length and to an unmatched control group.[12] However, this study did not mention flap creation technique and mean time interval between LASIK and cataract extraction. To add to this study, we found a negative correlation between axial length and cataract extraction age in both groups, which is in accordance with the previous studies.[13,14] Therefore, because there was no difference in axial length between our groups, the potential confounding effect of increased axial length was eliminated as a factor from this cohort.

Our study demonstrated significant power with respect to the number of eyes included in both groups. However, our results should be evaluated within their limitations, including the retrospective design of this study. Because all patients in the LASIK group had microkeratome-assisted flap creation, we are unable to compare our results to femtosecond-assisted flap creation, which uses a significantly lower level of suction for flap creation and thereby induces a smaller increase in intraocular pressure.[15] Furthermore, we are unable to compare our results to PRK due to the small amount of patients with PRK in our chart review. We did not have access to the pre-LASIK visual acuity in all patients included in the LASIK group because some did not undergo surgery at our institution. Patients who underwent LASIK at the Bascom Palmer Eye Institute all demonstrated a CDVA of 20/20 or better prior to LASIK surgery. We assume that patients not treated at Bascom Palmer Eye Institute underwent LASIK in accordance with accepted standards of care and that none underwent treatment while demonstrating ocular pathology (eg, cataract) that could potentially impact visual performance. Further studies include the effects of PRK and femtosecond laser-assisted LASIK on the age at the time of cataract surgery. Through an examination of each of these three subgroups (microkeratome-assisted LASIK, femtosecond laser-assisted LASIK, and PRK) we are hoping to further elucidate the potential relationship between corneal refractive surgery and lenticular change. Fortunately, newer technology will also allow us to measure and track progression of lens density changes after refractive surgery. This will help us further define potential relationships and changes leading up to subsequent cataract extraction.

There are two major potential confounding factors that may influence the timing of cataract surgery in this cohort of patients: axial length and differences in subjective visual symptoms determining the timing of a patient's presentation for cataract evaluation and potential surgery. It has been well established that patients with higher degrees of myopia develop cataracts at a faster rate.[14] To compensate for the known relationship between increased axial length and cataract formation, patients were matched by axial length. Additionally, we hypothesized that patients with a history of prior refractive surgery may be more scrutinizing of their vision, thus becoming more symptomatic from their cataract at an earlier age despite smaller degrees of cataract formation. To account for this subjective aspect of visual decline, patients were matched by their CDVA at the time of cataract evaluation (their last visit before surgery). Only patients with 20/30 visual acuity or worse were considered for inclusion in the study. Another limitation is the use of a subjective grading system for cataract density (LOCS III). The use of an objective cataract grading system would be ideal for matching the two groups of the current study; however, we are limited by the retrospective nature of this study.

This study assessed the timing of cataract extraction in patients with a history of microkeratome-assisted LASIK and compared with a group of controls matched for gender, CDVA before and after cataract extraction CDVA, UDVA before cataract extraction, cataract grade, and axial length who underwent cataract extraction without prior refractive surgery history. Patients with a history of microkeratome-assisted LASIK underwent cataract extraction a decade earlier than patients with similar demographic and ocular characteristics. Our study is unique because it is the first evidence that shows premature cataract formation in patients after refractive surgery after controlling for the confounding factors of axial length and gender, and the subjective aspect of patients with refractive surgery potentially being more sensitive to changes in visual decline. Further studies with other refractive subgroups, prospective design, and larger numbers will aid in further elucidating this relationship.

AUTHOR CONTRIBUTIONS

Study concept and design (NY, PC, VFD, KED); data collection (NY); analysis and interpretation of data (NY, DPW, SHY, KED);

writing the manuscript (NY, PC, VFD, KED); critical revision of the manuscript (VFD, DPW, SHY, KED); statistical expertise (NY, DPW); administrative, technical, or material support (NY, PC, VFD, KED); supervision (SHY, KED)

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