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Tilt of IOLs and change of axial length in patients of posterior capsular opacification after Nd:YAG laser capsulotomy

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后发性白内障患者行 YAG 激光后囊切开术后人工晶状体的偏移及眼轴的改变

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摘要

目的:研究后发障患者在行 YAG 激光后囊切开术后人工晶体有无发生偏移,以及眼轴是否发生变化。

方法:收集白内障超声乳化并人工晶体植入术后不同时间段内发生后发性白内障患者 14 例 18 眼。所有患者在行 YAG 激光术前均先参照标准对数视力表验光并获得最佳矫正视力,以眼前节 OCT 获得眼前段图像,并以 CMOS 测得眼轴。本研究中定义瞳孔所在的水平面与人工晶体的前表面所成的夹角为人工晶体偏移度(简称偏移度,单位:度)。完成相关检查后,对患者逐一行 YAG 激光后囊切开术,术后双氯芬酸钠滴眼液滴术眼一次,术后 1h,1wk 后对患眼行验光,眼前节 OCT 及 CMOS 检查。分别记录患眼人工晶状体的偏移度、眼轴长度及最佳矫正视力,并以 SPSS 进行统计分析。

结果:YAG 激光术前各例眼的平均偏移度为 2.896±2.286 度,平均眼轴为 23.56±0.55 mm;术后 1h 平均偏移度为 4.702±2.991 度,平均眼轴为 23.40±0.59 mm;YAG 术后 1h 较术前相比最佳矫正视力提高了平均 3.72±1.74 行。YAG 术后 1wk 回访患者有 9 例 12 眼,此 12 眼的 YAG 术后 1h 的平均偏移度为 3.175±1.791 度,术后 1wk 的平均偏移度为 3.434±1.835 度。YAG 术后 1h 与术前相比人工晶体偏移度的差异有统计学意义;术后 1h 与术前相比眼轴的差异无统计学意义;YAG 术后 1wk 与术后 1h 人工晶体偏移度的差异无统计学意义;YAG 术后 1h 较术前提高的最佳矫正视力行数与术后 1h 较术前人工晶体偏移度的差值具有相关性,相关系数为-0.523。

结论:后发障患者行 YAG 激光后囊切开术后人工晶体发生偏移,而眼轴长度几乎不变;且 YAG 术后人工晶体发生的偏移量越小,最佳矫正视力提高越多。

关键词:YAG 激光后囊切开术;人工晶体偏移度;眼前节 OCT;眼轴长度;最佳矫正视力;SPSS

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Abstract

• AIM: To study the tilt of the intraocular lens (IOL) after Nd:YAG capsulotomy (YAG) and variation of the axial length (AL) in patients with posterior capsular opacification (PCO).

• METHODS: The study involved 18 eyes of 14 patients with PCO after uncomplicated phacoemulsification surgery and IOL implantation. All patients had taken examinations, including testing best corrected visual acuity (BCVA) by using standard logarithmic visual acuity chart, images of ocular anterior segment and AL by OCT. After the examinations, YAG was operated upon all patients. Each eye received one drop of Diclofenac Sodium Eye Drops immediately after YAG, and patients had taken examinations listed above again. One week later, BCVA and OCT were tested as well. Data (BCVA, tilt of IOLs, and AL) were recorded and analyzed statistically by SPSS.

• RESULTS: Mean patient age was 73.93±6.94y, including 5 males and 9 females, 8 left eyes and 10 right eyes, altogether 14 patients with 18 eyes. In this study, tilt of IOLs was defined as the angle of anterior surface of IOL and pupil plane (briefly called Tilt, unit:°). Before YAG, mean Tilt was 2.896±2.286°, mean AL was 23.56±0.55mm. 1h after YAG, mean Tilt was 4.702±2.991°, mean AL was 23.40±0.59mm, and BCVA enhanced 3.72±1.74 lines. 1wk after YAG, 9 patients with 12 eyes were involved in the study. The mean Tilt of these 12 eyes was 3.175±1.791° 1h after YAG and 3.434±1.835° 1wk after YAG. There were significant differences between Tilt before YAG and Tilt 1h after YAG. There were no significant differences between AL before YAG and AL 1h after YAG. There were no significant differences between Tilt 1h after YAG and Tilt 1wk after YAG. The lines of enhancement of BCVA 1h after YAG was correlated to

differences between Tilt before YAG and Tilt 1h after YAG, of which the correlation coefficient was -0.523.

• CONCLUSION: IOLs of patients with PCO tilted after YAG, while AL rarely changed. After YAG, the less IOLs tilted, the more BCVA enhanced.

• KEYWORDS: Nd:YAG capsulotomy; tilt of IOLs; OCT of anterior segment; axial length; best corrected visual acuity; SPSS

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INTRODUCTION

Among patients after phacoemulsification with intraocular lens (IOL) implantation, there is a possibility of approximately 33% to become posterior capsular opacification (PCO)[1], which may severely affect patients' visions, or even their lives. It is now commonly accepted that the main reason contributing to PCO is the remaining of crystalline cells, thus making the capsule of lens blur[2-3].

Today an effective way to cure PCO is YAG[4]. There is evidence that YAG can help enhance the vision[5], contrast sensitivity[6], and binocular stereo vision[7-8], as well as lyse residual cortex[9], and reduce the wavefront aberrations[10-11]. And when the energy of Nd:YAG Laser is about 2 mJ, IOP and the depth of anterior chamber can almost remain unchanged after YAG[12-15].

Although the vision of PCO patients can be enhanced after YAG, visions of different patients enhanced differently. Many studies had explained the effectiveness and safety of YAG, but seldom analyze the tilts of IOLs and the relationships between the tilts of IOLs and the visions. Hence, this study aims to investigate the tilt of IOLs, variation of AL, and the relationships between the tilts of IOLs and the visions in PCO patients after YAG.

SUBJECTS AND METHODS

Subjects The study involves 14 patients with 18 eyes. The average age is 73.93±6.94 years old, with 5 males and 9 females, 8 left eyes and 10 right eyes.

Inclusion Standard 1) All patients with PCO; 2) All patients had taken phacoemulsification with IOL implantation; 3) BCVA of each eye was less than 1.0.

Exclusion Standard 1) Except PCO, patients had other ocular diseases, like fundus diseases, glaucoma, uveitis, corneal diseases, ocular carcinoma and trauma, *etc.*; 2) Except phacoemulsification with IOL implantation, patients had taken other ocular surgeries; 3) IOP of the eye was more than 21 mmHg; 4) The eye could not be dilated.

Methods The methods of the study included measuring BCVA by standard logarithmic visual acuity chart, images of ocular anterior segment and AL by OCT. The 18 eyes needed to take examinations listed above before YAG, which were tested by the same doctor. Meanwhile, fundus examination and IOP measurement were tested before YAG. After examinations, the same doctor operated YAG on each eye. Eyes received one drop of diclofenac sodium eye drops immediately after YAG, and patients took same examinations 1h after YAG. 1wk later, best corrected visual acuity (BCVA) and OCT were tested as well.

The methods of measuring BCVA included retinoscopy and subjective refraction. Retinoscopy was suitable for those whose visual acuity was less than 0.5, or those who cannot express themselves well. Subjective refraction was suitable for those whose visual acuity was no less than 0.5 and those who can express themselves well. BCVA was recorded by decimal recording.

Images of ocular anterior segment and AL was examined by OCT (Figure 1-3).

Tilt of IOL was defined as the angle formed by the plane of iris and the plane of IOL (Figure 4).

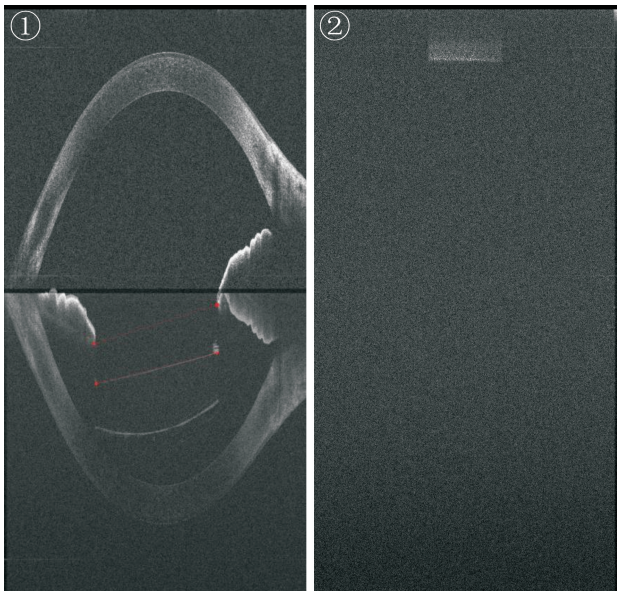

Figure 1 OCT of ocular anterior segment.
Figure 2 OCT of retinal reflection.

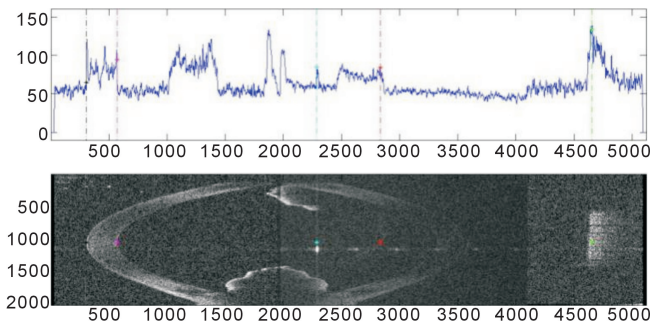

Figure 3 Measurement of AL by combining Figure 1 and Figure 2.

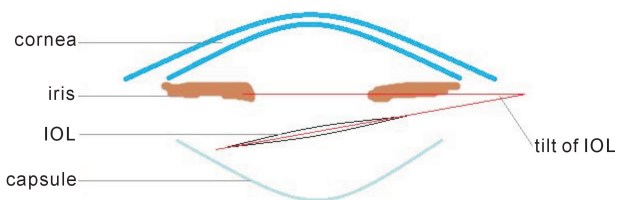

Figure 4 Model of measuring tilt of IOL.

Table 1 Statistical data of three results in the study

Parameters	Before YAG	1h after YAG	1wk after YAG
Tilt of IOLs	2.896±2.286(18[a])	4.702±2.991(18[a])	——
	——	3.175±1.791(12[a])	3.434±1.835(12[a])
AL	23.56±0.55(18[a])	23.40±0.59(18[a])	——
Enhancement of visual acuity	——	3.72±1.74(18[a])	——

Unit of Enhancement of visual acuity: line(s); [a]: refered to the eyes involved in the study

Table 2 Original data of three results of different periods in the study

Parameters	Tilt before YAG	Tilt 1h after YAG	Tilt 1wk after YAG	AL before YAG	AL 1h after YAG	BCVA Before YAG	BCVA 1h after YAG
1	1.634	3.847	3.496	23.98	23.99	0.1	0.16
2	2.599	1.716	1.78	24.02	23.89	0.3	0.8
3	2.843	4.446	3.936	23.6	23.79	0.2	0.6
4	1.524	5.471	5.831	23.38	23.22	0.2	0.5
5	4.928	5.958	——	24.46	24.89	0.3	0.9
6	2.459	2.995	——	23.15	22.96	0.1	0.5
7	5.726	6.533	——	24.37	22.95	0.05	0.4
8	1.147	5.833	5.617	22.74	22.72	0.2	0.6
9	7.353	3.953	3.332	23.03	22.44	0.1	0.3
10	0.146	1.377	1.518	23.39	23.61	0.1	0.7
11	5.202	0.59	0.06	23.15	23.12	0.1	0.4
12	5.02	4.682	4.59	22.59	22.64	0.5	0.8
13	1.624	5.533	——	24.51	23.54	0.7	0.7
14	2.526	1.377	1.48	23.65	23.78	0.6	1.0
15	0	5.234	5.221	23.61	23.31	0.2	0.6
16	0.944	2.555	2.022	23.4	23.49	0.05	0.3
17	6.268	10.441	——	23.23	23.4	0.16	0.5
18	0.188	12.087	——	23	22.81	0.9	1.0

Table 3 Results of normal distribution of Tilts

Parameters	Tilt before YAG	Tilt 1h after YAG	Tilt 1wk after YAG
P of normal distribution test	0.120	0.090	0.728

Table 4 Results of *t*-test of Tilts and AL

Parameters	Tilt before YAG—Tilt 1h after YAG	Tilt 1h after YAG—Tilt 1wk after YAG	AL before YAG—AL 1h after YAG
P of *t*-test	0.026	0.058	0.177

Table 5 Results of correlation analysis between Tilts and BCVA

Parameters	*P*	Correlation coefficient
Result of correlation analysis	0.026	−0.523

The unit of AL was millimeter (mm) and the unit of tilt of IOLs was degree (°). All the statistics were analyzed by SPSS.

RESULTS

Before YAG, mean Tilt of 18 eyes was 2.896±2.286°, mean AL was 23.56±0.55 mm. One hour after YAG, mean Tilt was 4.702±2.991°, mean AL was 23.40±0.59 mm. BCVA 1h after YAG had enhanced 3.72±1.74 lines compared with that before YAG. One week after YAG, there included 12 eyes of 9 patients. Mean Tilt of 12 eyes 1h after YAG was 3.175±1.791°, and mean Tilt of 12 eyes 1wk after YAG was 3.434±1.835°. There were significant differences between Tilt before YAG and Tilt 1h after YAG. There were no significant differences between AL before YAG and AL 1h after YAG. There were no significant differences between Tilt 1h after YAG and Tilt 1wk after YAG. The lines of enhancement of BCVA 1h after YAG was correlated to differences between Tilt before YAG and Tilt 1h after YAG, and the correlation coefficient was −0.523. Statistics were listed in Table 1 and Table 2.

Comparison between Tilt before YAG and Tilt 1h after YAG

According toTable 1, mean Tilt before YAG was 2.896±2.286°, mean Tilt 1h after YAG was 4.702±2.991°.

Making normal distribution test to the statistics of Tilt before YAG and Tilt 1h after YAG (Table 3).

According to Table 3, the differences between Tilt before YAG and Tilt 1h after YAG were analyzed by *t*-test (Table 4).

According to Table 1, mean Tilt 1h after YAG was 1.805° more than mean Tilt before YAG. According to Table 4, *P*-value of *t*-test between Tilt before YAG and Tilt 1h after YAG was 0.026<0.05. There were significant differences between Tilt before YAG and Tilt 1h after YAG (Figure 5).

Table 6 Results of regression analysis between Tilts and BCVA

Parameters	*P*	Regression coefficient	R^2 coefficient
Result of regression analysis	0.026	−0.831	0.228

Comparison between AL before YAG and AL 1h after YAG According to Table 1, mean AL before YAG was 23.56 ± 0.55mm, mean AL 1h after YAG was 23.40±0.59mm.

Making normal distribution test to the statistics of AL before YAG and AL 1h after YAG, and the consequence showed the statistics of AL catered to normal distribution. So the differences between AL before YAG and AL 1h after YAG were analyzed by *t*-test (Table 4).

According to Table 1, mean AL 1h after YAG was 0.158 mm less than AL before YAG. According to Figure 4, however, *P* of *t*-test between AL before YAG and AL 1h after YAG was 0.177>0.05. There were no significant differences between AL before YAG and AL 1h after YAG.

Comparison between Tilt 1h after YAG and Tilt 1wk after YAG 1wk after YAG, there included 12 eyes of 9 patients in the study. According to Table 1, mean Tilt 1h after YAG was 3.175±1.791°, mean Tilt 1wk after YAG was 3.434±1.835°.

Making normal distribution test to the statistics of Tilt 1h after YAG and Tilt 1wk after YAG (Table 3).

According to Table 3, the differences between Tilt 1h after YAG and Tilt 1wk after YAG were analyzed by *t* - test (Table 4).

According to Table 1, mean Tilt 1wk after YAG was 0.259° less than mean Tilt 1h after YAG. According to Table 4, *P* of *t*-test between Tilt 1h after YAG and Tilt 1wk after YAG was 0.058 > 0.05. There were no significant differences between Tilt 1h after YAG and Tilt 1wk after YAG (Figure 6).

Correlation of differences between Tilt before YAG and Tilt 1h after YAG to Lines of Enhancement of BCVA

According to Table 1, BCVA 1h after YAG enhanced 3.72± 1.74 lines more than that before YAG. Mean difference between Tilt before YAG and Tilt 1h after YAG was 2.96±2.77°.

SPSS was used to analyze the correlation of differences between Tilt before YAG and Tilt 1h after YAG to lines of enhancement of BCVA (Table 5).

According to Table 5, *P* of correlation analysis was 0.026< 0.05, which referred to that there were significant correlations between differences of Tilt before YAG from Tilt 1h after YAG and lines of enhancement of BCVA. Therefore, SPSS was used to make regression analysis of differences between Tilt before YAG and Tilt 1h after YAG to lines of enhancement of BCVA (Table 6).

According to Table 6, regression coefficient was −0.831, and *P* was 0.026, which meant there was linear relation between differences of Tilt before YAG from Tilt 1h after YAG and lines of enhancement of BCVA. R^2 coefficient was 0.228, which meant differences of Tilts could account for 22.8% the change of BCVA (Figure 7).

Table 7 Results of Tilts of two samples

Parameters	Mean tilt of IOLs	*P* of normal distribution test
Sample	2.93±1.87°	0.908
Sample(5min later)	2.90±1.79°	0.654

Table 8 Results of correlation and *t*-test of two samples

Parameters	Correlation coefficient	*P* of *t*-test
Consequence	0.994	0.683

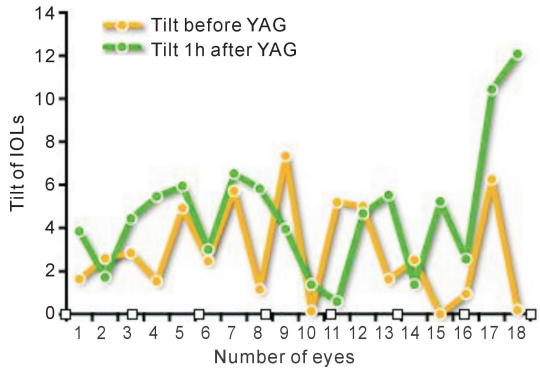

Figure 5 Comparison between Tilt before YAG and Tilt 1h after YAG.

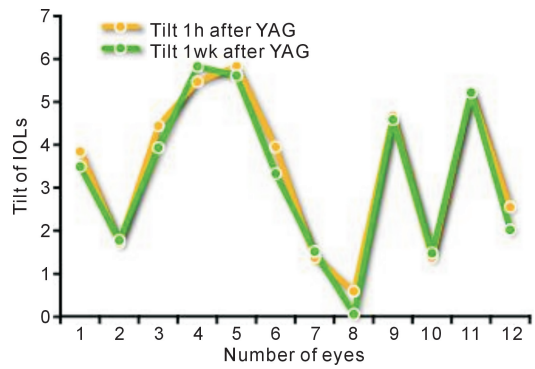

Figure 6 Comparison between Tilt 1h after YAG and Tilt 1wk after YAG.

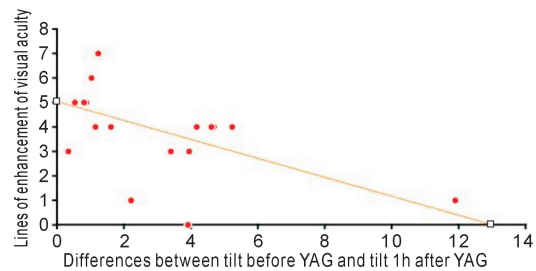

Figure 7 Linear relation between Tilts and BCVA.

Reliability Analysis In order to confirm the method of measuring Tilts used in this study, reliability analysis was required. Among all the 18 eyes involved in this research, 8 eyes were chosen randomly to take OCT twice at the same time

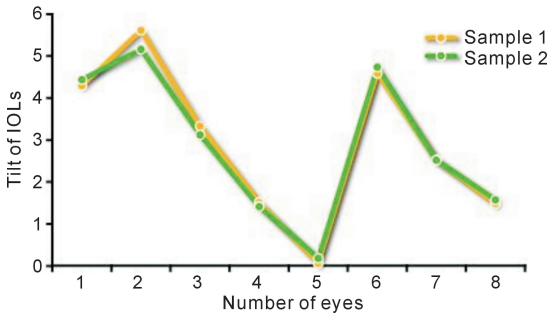

Figure 8 Comparison between the samples.

(5min interval). Statistics were recorded and analyzed by SPSS (Table 7).

According to Table 7, mean Tilts of the samples were 2.93±1.87° and 2.90±1.79°. *P* of normal distribution test of the samples were 0.908 and 0.654. So the differences were analyzed by *t*-test (Table 8).

According to Table 8, *P* of *t*-test was 0.683>0.05. There were no significant differences between the samples. Besides, correlation coefficient was 0.994, which meant the samples were highly correlated.

According to the results of reliability analysis, the method of measuring Tilts was reliable (Figure 8).

DISCUSSION

1) In this study, IOLs did tilt after YAG, while AL did not change; 2) Tilts was correlated with BCVA. The more Tilts were, the less BCVA enhanced. The less Tilts waere, the more BCVA enhanced. Therefore, it was concluded that different tilts of IOLs could partially lead to different enhancement of BCVA; 3) For the time being, the reasons why IOLs tilted after YAG were unknown. However, this might be because:

a) YAG might affect the tension of the posterior capsule, thus making IOLs tilt[16]; b) YAG broke the integrity of the posterior capsule and made the liquefied vitreous push IOLs, thus making IOLs tilt[17-20].

4) Some studies showed that YAG did not lead to tilt of IOLs, while my study confirmed the opposite opinion. Meanwhile, tilt of IOLs also meant the change of optic axis, which might affect visual acuity. And this was also confirmed in this study;

5) There were still some deficiencies. a) Whether IOLs tilted was discussed, but the reasons why YAG would lead to the tilt was not discussed in detail; b) OCT showed the horizontal plane of IOLs, which could not show three-dimensional structure of IOLs; c) The number of eyes involved in the study was not so much.

Generally speaking, the results and the conclusions of this study were meaningful. 1) It was analyzed that IOLs did tilt after YAG and that tilt of IOLs was correlated with BCVA. 2) The method of measuring tilt of IOLs by OCT was convenient and reliable. 3) With the increasing requirement of multifocal IOLs, the conclusions of this study would be more meaningful and useful.

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