

Effect of Neodymium:YAG (ND:YAG) Laser Capsulotomy on the Corneal Endothelium in Treating Posterior Capsule Opacity

Suthanee Sonthirathi, M.D.

Navapol Kanchanaranya, M.D.

Department of Ophthalmology, Faculty of Medicine, Thammasat University

Objective : To evaluate the effect of neodymium:YAG (Nd:YAG) laser capsulotomy on the corneal endothelium after applied on the posterior capsule opacity (PCO)
Design : Prospective observational study

Methods : Patients with a significant posterior capsular opacity treated by Nd:YAG capsulotomy were included. Detailed history and ophthalmic examinations including visual acuity and slit lamp examination were assessed before performing Nd:Yag laser capsulotomy. Corneal endothelial cell counts were obtained before and at 1 month and 3 months after laser performed. The parameters of laser power were also recorded.

Results : Forty one patients with postoperative posterior capsular opacity, age ranged from 34 to 82 years old, were included between July 2012 and December 2012. Twenty three patients were female and eighteen were male. The mean pulse energy was 1.793 millijoules (SD=0.36; range 1.1-2.6). Mean number of pulses per capsulotomy was 43.56 (SD=13.41; range 21-80). Mean total energy per capsulotomy was 78.80 millijoules (SD=31.41; range 34-160). Mean pre-laser corneal endothelial cell count was 2213.39 cells (SD=318.97; range 1653-2831). Mean post-laser corneal endothelial cell count at 1 month was 2177.46 cells/mm²

(SD=373.50; range 1602-2921). Mean post-laser corneal endothelial cell count at 3 months was 2237.36 cells/mm² (SD= 350.15; range 1624-2904). The difference between pre- and post-laser corneal endothelial cell count at 1 and 3 months were not statistically significant. No correlation was found between the total energy and the corneal endothelial cell loss at 1 and 3 months after laser.

Conclusion : Nd:YAG laser capsulotomy in PCO treatment did not result in significant loss of endothelial cell up to 3 months after deliver. No correlation was found between the total energy of the laser and the corneal endothelial cell loss at 1 and 3 months.

Keywords: Posterior capsule opacity, Nd:YAG capsulotomy, Corneal endothelium

Introduction

Posterior capsule opacity (PCO), developed by the pearl formation or fibrosis, is the most common complication following cataract surgery. Elschnig's pearl is the most common type that is due to the proliferation of the lens epithelial cell layer on the posterior capsule. The other type such as capsular

fibrosis due to fibrous metaplasia of epithelial cells is less common.^{1,2} The opacification results in not only the reduction in visual acuity (VA) and contrast sensitivity by obstructing the view but also glare and monocular diplopia by scattering the light that perceived by patients.

The neodymium yttrium aluminum garnet (Nd:YAG) laser is a solid type of laser, causes disruption of tissue by ionization mode of action or photodisruption with a wavelength of 1,064 nanometres in the infrared radiation.^{1,3} It is commonly used to disrupt the posterior capsule opacity following cataract surgery, iridotomy and cut the vitreous bands^(3,4).

Despite many useful benefits, Nd:YAG capsulotomy procedure is thought to be associated with a lot of complications including transient rise of intraocular pressure, corneal endothelium damage, cystoid macular edema (CME), retinal detachment, rupture anterior hyaloid face, posterior subluxation of intraocular lens, and macular hemorrhage.^{2,5,6,7}

We designed this study to find whether corneal endothelial cell will be lost after performing Nd:YAG capsulotomy and to evaluate the effect of Nd:YAG laser capsulotomy on the corneal endothelium in PCO treatment.

Materials and methods

This prospective observational study was conducted from July 2012 to December 2012 at the department of Ophthalmology, Thammasat University Hospital. Patients with a significant posterior capsular opacity were treated by Nd:YAG capsulotomy. Ethical study protocol was approved by Faculty

Research Ethics Committee. The inclusion criteria was pseudophakic status with significant posterior capsular opacity. The exclusion criteria were corneal disease including infectious- or non-infectious keratitis, corneal dystrophy or corneal degeneration and uncontrolled glaucoma.

All patients were given the informed consent at preoperative examination. Standard preoperative examinations were performed. Preoperative data sheet included age, gender, best corrected visual acuity (BCVA), intraocular pressure (IOP) and corneal endothelial density by specular microscope (Confoscan 4-CS4, NIDEK, Italy)

All posterior capsulotomies were performed by YC-1800 (Ophthalmic Yag Laser System, NIDEK, Japan) after dilation with topical 1% tropicamide. Topical 0.5% proparacaine hydrochloride was instilled before placing a contact lens (40X) on the cornea. A Q-switched Nd:Yag laser was applied with a minimal number of bursts and energy varying from 1 to 3 millijoules. All patients were prescribed a topical steroid eye drops and other medications if necessary. Corneal endothelial cell count was performed using specular microscope. The total area of the cells counted was used to calculate the mean endothelial cell density per square millimeter by a fixed-frame cell analysis technique.

All patients were followed-up as usual. Follow-up examination included BCVA, IOP and slit lamp examination. Corneal endothelial cell density was obtained at post-laser 1 month and 3 months. The statistical analysis was performed using SPSS version 18.1 version? (SPSS, Chicago, IL). P value less than 0.5 was considered statistically significant.

Results

Forty one eyes of 41 patients (mean [SD] age, 67.27 [10.21] years; range 34-82) with significant postoperative posterior capsular opacity were included from July 2012 to December 2012. Female was predominant. All patients underwent corneal endothelial cell count at 1 month after Nd:YAG capsulotomy. At 3 months, 28 patients (68.3%) remained (Table 1).

The mean pulse energy (SD) was 1.793 (0.360) millijoules (range, 1.1-2.6). The mean number of pulses per capsulotomy (SD) was 43.56 (13.41) pulses (range,

21-80). The mean total energy per capsulotomy (SD) was 78.80 (31.41) millijoules (range, 34-160).

The mean pre-laser corneal endothelial cell count (SD) was 2213.39 (318.97) cells/mm² (range, 1653-2831). The mean post-laser corneal endothelial cell count at 1 month (SD) was 2177.46 (373.50) cells/mm² (range, 160-2921). The mean post-laser corneal endothelial cell count at 3 months (SD) was 2237.36 (350.15) cells/mm² (range, 1624-2904) (Table 2). The difference between the pre and post-laser corneal endothelial cell count at 1 and 3 months were not statistically significant (Table 3, Table 4).

Table 1 Demographic Characteristics

	No. (%)
No of eyes (patients)	41 (41)
Age, y, mean (SD)	67.27 (10. 21)
Gender	
Male	18 (43.9)
Female	23 (56.1)
Eye	
Right eye	22 (53.7)
Left eye	19 (46.3)

Table 2 Nd: YAG Capsulotomy Parameters

Parameters	Results
Spot laser power, millijoules	
Mean (SD)	1.793 (0.360)
Median (range)	1.5 (1.1-2.6)
Number spot laser, spots	
Mean (SD)	43.56 (13.41)
Median (range)	59 (21-80)
Total laser energy, millijoules)	
Mean (SD)	78.80 (31.41)
Median (range)	126 (34-160)

Table 3 Endothelial Cell Density before and after Nd:YAG Capsulotomy

Parameter	Pre-laser	Post-laser 1 month (n=41)	Post-laser 3 months (n=28)
Corneal endothelial cell density, cell/mm ²			
Mean (SD)	2213.39 (318.97)	2177.46 (373.50)	2237.36 (350.15)
Median (range)	1178 (1653-2831)	1319 (1602-2921)	1218 (1624-2904)

Table 4 Change of Corneal Endothelial Cell Count after Nd:YAG Capsulotomy

Parameter	Nd: YAG capsulotomy		
	Pre-laser – Post-laser 1 month	Pre-laser –Post-laser 3 months	Post-laser 1 month –Post-laser 3 months
Corneal endothelial cell loss, cell/mm ²			
Mean (SD) P value	35.93 (156.19) 0.149	-0.39 (124.72) 0.987	1.00 (149.21) 0.972

Discussion

Nowadays, cataract surgery nowadays is a commonly preperformed procedure in elderly patients. The most common complication after having standard phacoemulsification or extracapsular cataract extraction is posterior capsule opacity. Posterior capsular opacification is caused mainly by the remnant lens epithelial cell proliferation and migration, epithelial-mesenchymal transition, collagen deposition, and lens fiber generation. YAG capsulotomy is a common noninvasive procedure performed to remove the opacification by using a wavelength to disrupt the opacification but can be associated with significant complications. Possible complications include retinal detachment, IOL damage, cystoid macular edema, intraocular pressure increase, iris hemorrhage, IOL subluxation, exacerbation of localized endophthalmitis and corneal edema.

The corneal endothelium is a single layer of cells on the inner surface of the cornea. Human endothelial cell density is approximately 6000 cells/mm² during the first month of life but decreases throughout life^{8,9}. The endothelium must serve functions to maintain the health and clarity of the stroma. Endothelial cell loss, if sufficiently severe, can cause endothelial cell density to fall below the threshold level needed to maintain corneal clarity. Leading causes of endothelial loss include inadvertent endothelial trauma from intraocular surgeries or lasers.

Evaluation by scanning electron microscopy revealed that rabbit eye which underwent experimental anterior capsulotomy by Q-switched Nd:YAG laser suffered no endothelial damage¹⁰. However, previous studies noted that significant changes of central corneal thickness at one day, week, month and three months

after capsulotomy were observed. Highest relative percentage change at first day was noted⁵. Another study demonstrated significant endothelial cell loss at the 1-year follow-up⁴. We designed this study to find whether corneal endothelial cell would be changed after performing Nd:YAG capsulotomy to evaluate the effect of Nd:YAG laser capsulotomy on the corneal endothelium for posterior capsule opacity. Despite wide clinical use, little is known about its damaging effects on the ocular tissues particularly on the corneal endothelium.

In our study, the mean age of patients was 67 years old due to these procedures are used following cataract surgery that is commonly performed in elderly patients. Our results are corresponding with the previous studies that reported a clinically insignificant corneal endothelial damage after performing Nd:YAG capsulotomy. Results indicated no correlations between energy of laser and mean corneal endothelial cell density loss. No significant complication was found in this study after performing Nd:YAG laser capsulotomy.

The variation in the absolute numbers of cell lost may also be attributable to other several factors such as the accuracy of technician's endothelial cell measurement, the target tissue-endothelium distance and the duration from cataract surgery to laser capsulotomy. Further studies are necessary to identify the significance of these factors. There was a high rate of loss of follow-up at 3 months due to the improvement of visual quality. This resulted in an unreliable data at 3 months. This study is also limited by a small sample size and timing to follow-up. To verify the effect of Nd:YAG capsulotomy, a large number of comparative studies and long term follow-up time needed.

References

1. Ejaz Ahmad Javed, Zia Ud Din Ahmad, Muhammad Sultan. Nd:YAG laser capsulotomy and complications. Professional Med J Dec 2007; 14(4):616-9.
2. Slomovic AR, Parrish RK, 2nd, Forster RK, Cubillas A. Neodymium-YAG laser posterior capsulotomy. Central corneal endothelial cell density. Arch Ophthalmol. 1986 Apr;104(4):536-8.
3. Aslam TM, Devlin H, Dhillon B. Use of Nd:YAG laser capsulotomy. Survey of Ophthalmology. 2003;48(6):594-612.
4. Wu SC, Jeng S, Huang SC, Lin SM. Corneal endothelial damage after neodymium:YAG laser iridotomy. Ophthalmic Surg Lasers. 2000 Sep-Oct;31(5):411-6.
5. Wroblewska-Czajka E, Wylegala E. [Central corneal thickness measurement by optical coherence tomography after Nd: YAG capsulotomy in patients with posterior capsule opacity]. Klin Oczna. 2008;110(7-9):259-64.
6. Mahtab Alam Khazada, Shafi Muhammad Jatoi, Ashok Kumar Narsani, Syed Asher Dabir, Siddiq Gul. Is the Nd:YAG laser a Safe Procedure for Posterior Capsulotomy?. Pak J Ophthalmol 2008, Vol.24 No.2:73-8.
7. M G Kerr Muir, E S Sherrard. Damage to the corneal endothelium during Nd/YAG photodisruption. British Journal of Ophthalmology, 1985, 69, 77-85.
8. Bahn CF, Glassman RM, MacCallum DK, Lillie JH, Meyer RF, Robinson BJ et al. Postnatal development of corneal endothelium. Invest Ophthalmol Vis Sci 1986; 27: 44-51.
9. Bourne WM, Nelson LR, Hodge DO. Central corneal endothelial cell changes over a ten-year period. Invest Ophthalmol Vis Sci 1997; 38: 779-82.
10. Li XL. Experimental study of corneal endothelial damage by Nd:YAG laser. Zhonghua Yan Ke Za Zhi. 1993 May;29(3):180-2.

ผลของการยิงเลเซอร์ neodymium:YAG เปิดถุงหุ้มเลนส์ ที่มีต่อเซลล์เอนโดทิลีียมของกระจกตาในผู้ป่วยถุงหุ้มเลนส์ขุ่น

แพทย์หญิงสุณี สันธิรติ

ผู้ช่วยศาสตราจารย์ นายแพทย์ฉนวนพล กาญจนารัตน์

ภาควิชาจักษุวิทยา คณะแพทยศาสตร์ มหาวิทยาลัยธรรมศาสตร์

บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาผลของการยิงเลเซอร์เปิดถุงหุ้มเลนส์ (Nd: YAG Capsulotomy) ที่มีต่อการเปลี่ยนแปลงของ เซลล์เอนโดทิลีียมของกระจกตา

วิธีดำเนินการวิจัย : ผู้ป่วยที่มีภาวะถุงหุ้มเลนส์ขุ่นและรบกวนระดับการมองเห็นถูกคัดเลือกเข้ามารับการรักษาด้วยวิธียิงเลเซอร์เปิดถุงหุ้มเลนส์ ผู้ป่วยทุกคนได้รับการเก็บประวัติ บันทึกการมองเห็น ข้อมูลการตรวจร่างกายทางตาโดยเครื่องมือ Slit lamp ก่อนรับการยิงเลเซอร์ ข้อมูลจำนวนเซลล์กระจกตาก่อนและหลังการยิงเลเซอร์ที่ 1 เดือน และที่ 3 เดือน และข้อมูลระดับพลังงาน ที่ใช้ในการยิงเลเซอร์เปิดถุงหุ้มเลนส์ในแต่ละราย

ผลการวิจัย: ผู้ป่วยจำนวน 41 คน เก็บข้อมูลตั้งแต่เดือนกรกฎาคม ถึงเดือนธันวาคม 2556 มีช่วงอายุระหว่าง 34 - 82 ปี ประกอบด้วยเพศหญิง 23 คน เพศชาย 18 คน พลังงานเฉลี่ยที่ใช้เท่ากับ 1.793 มิลลิจูล

(SD = 0.360; ช่วงระยะ 1.1- 2.6) จำนวนครั้งที่ยิงในแต่ละรอบ เท่ากับ 43.56 ครั้ง (SD = 13.41; ช่วงระยะ 21-80). พลังงานรวมที่ใช้ในแต่ละรอบ เท่ากับ 78.80 มิลลิจูล (SD = 31.41; ช่วงระยะ 34-160) จำนวนเซลล์กระจกตาดีก่อนยิงเลเซอร์ เท่ากับ 2213.39 เซลล์ต่อตารางมิลลิเมตร (SD = 318.97; ช่วงระยะ 1653-2831) หลังยิงเลเซอร์ที่ 1 เดือน เท่ากับ 2177.46 เซลล์ต่อตารางมิลลิเมตร (SD = 373.50; ช่วงระยะ 1602-2921) และที่ 3 เดือน เท่ากับ 2237.36 เซลล์ต่อตารางมิลลิเมตร (SD = 350.15; ช่วงระยะ 1624-2904) จากการคำนวณทางสถิติ พบว่า ไม่พบความแตกต่างอย่างมีนัยสำคัญของจำนวนเซลล์กระจกตาดีก่อนยิงเทียบกับหลังยิงเลเซอร์ ที่ 1 เดือนและที่ 3 เดือน

สรุป: ไม่พบความแตกต่างอย่างมีนัยสำคัญของจำนวนเซลล์กระจกตาดีก่อนยิงเทียบกับหลังยิงเลเซอร์ ที่ 1 เดือนและที่ 3 เดือน และไม่พบความสัมพันธ์ระหว่างพลังงานรวมกับการเปลี่ยนแปลงของเซลล์เอนโดทิลีียมของกระจกตาที่ 1 เดือนและที่ 3 เดือน