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Effect of ND: YAG Laser Capsulotomy on Corneal Endothelium

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Abstract

Background: Posterior capsular opacification (PCO) is the most common delayed complication of cataract surgery with IOL implantation. The incidence of (pco) was reported to be 20.7% at two years and 28.7% at five years after cataract surgery. The purpose of our work is to evaluate the corneal endothelium after Nd:YAG laser capsuolotomy by specular microscope. **Patients and Methods:** The study included 60 patients, age ranging from 18 to 65 years. This is a descriptive longitudinal study. This study conducted in "Memorial institute of ophthalmic research in Giza". **Results:** Nd:YAG laser used to perform posterior capsulotomies on patients that had undergone extracapsular cataract extraction. Only 7 (11.7%) patients had visual acuity improved to 0.3 less improvement in visual acuity. Vision was improved in all patients at least by one line. Visual outcome was not affected by complication. We did not document rise of IOP in any of our patient IOP after operation. **Conclusion:** Diminution of vision 2-3 years after successful cataract surgery became the chief complaint this is due to posterior capsule opicification, several advances and research has been done to prevent PCO by improving the surgical techniques, better IOL materials and design, use of therapeutic drugs but Nd:YAG laser capsulotomy is considered safe and with a low risk of complication.

Keywords: ND: YAG Laser, Capsulotomy, Corneal Endothelium.

1. Introduction*:*

Posterior capsular opacification is the most common delayed complication of cataract surgery with IOL implantation. This results due to proliferation and migration of reminant epithelial cells that form clump and fibrosis on the posterior lens capsule leading to posterior capsular opacification(PCO). There are three main sources of cells with a potential to cause opacification of capsular bag

1) Cuboidal epithelial cells lining the anterior capsule these have no propensity for migration, they undergo fibrous metaplasia and proliferate in situ.

2) The cells at the equatorial lens bow have an increased level of mitotic activity. These cells are migratory, therefore they grow along the posterior capsule giving rise to bladder cells.

3) Finally, the residual cortical fibers from the equatorial lens bow become dislodged and float freely with in the bag. They may remain localized or migrate centrally into the visual axis.

The incidence of (pco) was reported to be 20.7% at two years and 28.7% at five years after cataract surgery. The application Nd:YAG laser for posterior capsulotomy as a treatment for PCO showed itself to be an effective alternative to surgical dicsission avoiding such complications as endophthalamitis and vitrous loss, although Nd:YAG laser capsulotomy is accepted as standard treatment for PCO and has been found effective and safe, its not without complications [(1)].

The development of the Nd:YAG laser as an ophthalmic instrument and its application in the posterior capsule coincided with the conversion from intracapsular to extracapsular surgical techniques in cataract surgery. Before the introduction of the Nd:YAG laser, only surgical cutting or polishing of the posterior capsule could manage opacification of the posterior capsule following cataract extraction. Nd:YAG laser posterior capsulotomy introduced a technique for closed-eye, effective, and relatively safe opening of the opacified posterior capsule. [(2)] Although Nd:YAG laser capsulotomy presents the advantage of being non-invasive and effective method to treat PCO, the corneal endothelium may be damaged by laser radiation [(3)]. A single layer of corneal endothelial cells covers the posterior surface of the cornea in a well-arranged mosaic pattern. These cells are uniformly 5 µm in thickness and 20 µm in width and are polygonal (mostly hexagonal) in shape. [(4)], the cell density is about 3500 cells/mm2. [(5)].

One of the most important functions of the endothelium is to maintain a relative state of corneal dehydration by means of an active transport mechanism,The corneal endothelium governs fluid and solute transport across the posterior surface of the cornea and maintains the cornea in astate of slightly dehaydrated that is required for optical transparency The endothelium also prevents aqueous from entering the stroma by acting as a barrier aided by its tight cell–cell junctions[(6)]. any disturbance of metabolic pump , barrier function or corneal haydration lead to endothelial damage.

Specular microscopy is a noninvasive photographic technique that allows you to visualize and analyze the corneal endothelium. Using computer- assistedmorphometry, modern specular microscopes analyze the size, shape and population of the endothelial cells [(7)].

The aim of our work is to evaluate effect Nd:YAG laser on the corneal endothelium after capsuolotomy.

2. Patients and Methods:

This was a descriptive longitudinal study performed in “Memorial institute of ophthalmic research in Giza” The study included 60 patients, age ranging from 18 to 65 years.

2.1 Inclusion Criteria:

1- Age from 18 to 65 years old.

2- YAG laser treatment capsolotomies

3- Patients who did ECCE or Phacoemulisifaction

❖ Exclusion Criteria

1- Previous corneal surgery

2- Corneal scars or opacities.

3- Chronic use of topical medications e.g steroids

4- Systemic collagen diseases e.g:marfan, Danlosehler syndrome.

5- Previous history of corneal ulcers

2.2 All patients underwent the following

- Full medical and ophthalmic history.
- Best corrected visual acuity.
- Slit lamp examination of the anterior segment and posterior segment.

A. Pre Op:

Consent of the patient taken and procedure explained to patient. Visual acuity recording for distant vision and with near vision chart for near vision. IOP recorded by applanation - the pupil is adequately dilated before surgery with tropicamide 1% eye drop 3times at 10min interval(B/E). Patient subjected to specular microscopy (TOPCON sp-1p). After dilation of pupils both indirect & direct ophthalmoscopy is performed to rule out/exclude any pathology of posterior segment, and type and grade of PCO. Patient was comfortably be seated on tool infornt of the laser slit lamp (Visulaze yag 3) with chin on chin rest and forehead on forehead rest and head band applied. - Now paracaine (proparacaine) E.d one drop is instilled once in operating eye.

B. Intra-Op:

The patient fixes the red light/green light by other eye (non-operating) - The slit lamp is focused on posterior capsule and the YAG is switched on. - The energy level's fed in to the computer. Usually 7 to 1mj, lower power setting are used initially and later increased as required. – contact lens was applied Capsulotomy started by marking the centre of pupil, shots are applied around it. Starting from 12'o'clock position and going clockwise until a satisfactory opening is made. - Energy and shots were recorded.

Post laser treatment - Topical nepafenac eye drop 4 times a day for 7 days to all the patient. – topical Brimonidine eye drop twice daily.

C. Post-Op:

Immediate post op - pt is examined on slit lamp for complication of ant segment, uveitis for keratic precipitates, flare and haemorahage on 7th day or 4^{th}Post op day. - IOP is recorded, patient subjected to specular microscopy, visual acuity and near vision. - post segment pathologies & post op complication has also been ruled out, after recording, first visual activity, near vision secondly IOP, by dilating the pupils.

Data Analysis:

The collected data tabulated, coded and analyzed using *SPSS* for Windows 7, version 23. Continuous variables will be presented as mean values ± standard deviation (SD), and categorical variables presented as percentages. Comparisons among data done using suitable statistical tests. *P*-values < 0.05 will be considered as statistically significant.

Ethical Consideration:

All the individuals included in the study informed was about the procedures regarding the study and informed of their rights to refuse participation or withdraw from the study without having to give reasons. Participants were guaranteed anonymity and all information provided treated with confidentiality. The required administrative regulations fulfilled. The ethical approval of the faculty of medicine, Beni-Suef University research ethical committee (REC) obtained prior to the beginning of the work.

3. Results:

Table (1): Age and sex distribution of the studied population; (n= 60):

Descriptive Statistics	
Age; (years)	
Mean ±SD	57.48 ±8.1
Minimum	32
Maximum	65
Range	33
Sex; N (%)	
Male	21 (35%)
Female	39 (65%)

Table (2): IOP before and after Operation; (N= 60):

	IOP before	**IOP after**	***p-value****
Mean ±SD	18.05 ±3.3	17.95 ±3.1	0.635
Minimum	12	13	
Maximum	26	28	
Range	14	15	

**p-value ≤0.05 is considered significant by paired sample t-test.*

Table (2) demonstrates no statistically significant difference between IOP before and after operation where the mean values were (18.05 vs. 17.95) before and after operation respectively with non-significant p-value > 0.05.

Table (4): Distribution of Studied Population by Follow-up day Post-Operative; (N= 60):

	Frequency	Percent
Fourth day	45	75.0
Seventh day	15	25.0
TOTAL	**60**	**100.0**

Table (5): Visual Acuity before and after Operation; (N= 60):

	Visual Acuity before	Visual Acuity after	*p-value*
Mean ±SD	0.17±0.1	0.61±0.2	**0.001***
Minimum	0.10	0.70	
Maximum	0.30	0.90	
Range	0.20	0.20	

**p-value ≤0.05 is considered significant by paired sample t-test.*

As illustrated in table (5); there was significant improvement in the visual acuity post-operative where the mean visual acuity was (0.17 vs. 0.61) before and after operative respectively; p-value = 0.001.

Table (6): Comparison between before and after visual acuity regarding the studied parameters

	Before	After	p-value
CCT (central corneal thickness)			
Mean ±SD	513.35 ±28.5	514.86 ±30.8	0.340
Minimum	451.00	434.00	
Maximum	573.00	598.00	
Range	122.00	164.00	
CD (cells density)			
Mean ±SD	1975.68 ±582.7	1888.633±580.8	**0.001***
Minimum	747.00	727.00	
Maximum	3448.00	3335.00	
Range	2701.00	3335.00	
CV (coefficient variation)			
Mean ±SD	0.32 ±0.1	0.32 ±0.1	0.445
Minimum	0.17	0.24	
Maximum	0.59	0.48	

Range	0.42	0.24	
HEX (hexagenality)			
Mean ±SD	0.55 ±0.1	0.58 ±0.1	0.958
Minimum	0.31	.31	
Maximum	0.70	.78	
Range	0.39	.47	
N (number of cells)			
Mean ±SD	130.38 ±72.3	133.43 ±66.4	**0.015***
Minimum	29.00	13.00	
Maximum	331.00	280.00	
Range	302.00	267.00	
MIN (minimum			
Mean ±SD	233.63 ±89.3	260.15 ±156.0	0.734
Minimum	117.00	119.00	
Maximum	587.00	1202.00	
Range	470.00	1083.00	
MAX (maximum			
Mean ±SD	1143.80 ±494.3	1241.63 ±581.9	0.124
Minimum	638.00	582.00	
Maximum	3422.00	3053.00	
Range	2784.00	2471.00	
AVG			
Mean ±SD	554.8667 ±191	579.6833 ±224.8	0.060
Minimum	290.00	166.00	
Maximum	1338.00	1376.00	
Range	1048.00	1210.00	
SD			
Mean ±SD	185.53 ±107.9	191.01 ±104.7	**0.011***
Minimum	92.00	93.00	
Maximum	720.00	664.00	
Range	628.00	571.00	

**p-value ≤0.05 is considered significant by paired sample t-test.*

Table (7): Rate of Change in the Corneal Density (CD) before and after operation in the studied population; (N= 60):

CD	Descriptive Statistics
Minimum	-2.84%
Maximum	25.04%
Range	27.88%
Mean ±SD	4.77 ±5.3%

As demonstrated in table (7); Rate of change was calculated by calculating the difference between pre- and post- operative assessment then divided by the original pre-operative assessment and finally multiplied by 100. The Rate of Change in the Corneal Density (CD) before and after operation in the studied population was ranged from -2.84% to 25.04% with a mean rate of change as 4.77 ±5.3% (SD) in the cell density.

4. Discussion:

The Neodymium-YAG laser has become popular non-invasive technique of creating a posterior capsulotomy in both aphakic and pseudophakic eyes. Its safety and efficacy can be argued but it has established its place as a standard treatment for PCO replacing surgical capsulotomy **[8].**

We used the Nd:YAG laser to perform posterior capsulotomies on 60 eyes of 60 patients that had undergone extracapsular cataract extraction 21 (35%) of our cases were male and 39 (65% were female). The average age of these patients was 57 years, the range being from 18 years to 65 years. The posterior capsulotomy was performed on an average of 24 months after cataract extraction.

Improvement in visual acuity is the primary end point for successful neodymium: YAG (Nd: YAG) laser posterior capsulotomy for posterior capsule opacification ***Oztas et al.*****[9]** showed that the BCVA increased up to the first-month follow-up.In eyes with Posterior Capsular Opacification, in our study the Nd: YAG laser was effective in clearing pupillary opening in all 60 eyes (100%). In another study by **Hossain et al[10].**, visual outcome of 500 patients before and after capsulotomy was compared and 80% individuals showed improved visual acuity of ≥6/12.

In our study, pre-laser best corrected visual acuity ranged from 0.1 to 0.3. Improvement in visual acuity was excellent in our study. Post-laser visual acuity ranged from 0.3 to 0.9 or more. Only 7 (11.7%) patients had visual acuity improved to 0.3 less improvement in visual acuity was due to underlying pathology e.g myopic changes and old ages. In our study we did not observe decrease in visual acuity than pre-laser visual acuity in any case. Vision was improved in all patients at least by one line. This is probably

due to exclusion of cases from study with pre-existing ocular diseases which could prevent improvement in visual acuity. In our study visual outcome was not affected by complication.

An increase in IOP after capsulotomy is common but is temporary **(11).** We did not document rise of IOP in any of our patient IOP after operation where the mean values were (18.05 vs. 17.95) before and after operation. Respectively with non-significant p-value > 0.05, it may be due to the fact that all patients were treated with topical brimindine post laser for a week. **Gopinath et al. (12)** noticed that elevated IOP is recognized as the most common although usually transient, complication following Nd: YAG laser capsulotomy. A transient rise in IOP after Nd:YAG laser capsulotomy has been well-documented. In a study done on 66 patients, Slomovic and Parrish**(13).** found that 55% *patients* had significantly raised IOP following YAG laser therapy.

Wroblewska -Czajka et al. (14) reported that postoperative CCT values increased compared to CCT values before the procedure. **Oztas et al. (9)** suggested that a statistically significant 10 µm decrease in CCT was detected after Nd:YAG capsulotomy**. Ali Simsek (15)** reported that no association was found between the capsulotomy and CCT values. In our study, no significant change was found in the CCT. The mean central corneal thickness before laser was 513.53 µm and was found to be 514.86 µm after laser, which was not significant. **Allan R. Slomovic et al. (16)**. The difference between the mean preoperative and postoperative cell density was 42 cells per square millimeter (2.3% cell loss). There was no significant correlation between central corneal endothelial cell loss and the laser energy used.

In our study, ECD varied from 747 to 3448 cells/ mm^2 with a mean of 1975.68 cells/mm^2 before laser treatment. Post laser the mean ECD was 1888.63 cells/ mm2 ($P < 0.0001$). The difference was found to be highly significant. In a similar study by **Allan et al.(16)** the central corneal endothelial The mean pre-laser endothelial cell count was 1.840 cells/mm^2 and post laser endothelial cell count was 1.798 cells/mm^2.in anthor study **(17).**corneal endothelium was analyzed in 33 patients (17 aphakic and 16 pseudophakic). The authors found a significant correlation between the endothelial cell loss and the total energy delivered

Hexagonality:is the predominant cell shape in the normal endothelium; thus deviations in the percentage of cells, which are hexagonal, can be used as an index of cell shape variation (pleomorphism). Hexagonality of corneal cells varied from 31% to 70% with a mean of 55% pre-laser. And verified from 31% to 71% with mean 58% (P 0.0001) post laser which was found to be not clinically significant. In other study they found significance. Hexagonality of corneal cells varied from 49% to 84% with a mean of 72.22% pre-laser. At 1 week, it was 71.42% ($P < 0.005$) and at 12 weeks was 70.22% ($P < 0.0001$) which was found to be clinically significant **(18)**.

The CV is coefficient of variation in the sizes of the endothelial cells at baseline pre laser was 0.32, and post laser was 0.32 ($P > 0.05$). We did not find any significant difference.

The variation in the absolute number of cells lost may be attributable to several factors like target tissue/ endothelium distance, the nature of the tissue being disrupted, differences in delivery of the laser energy (e.g., number of bursts, the number of pulses per burst, mode of delivery) and quantity of energy.

5. Conclusion:

Nd:YAG laser capsulotomy is considered safe ,easy and also carries a low risk of complication.

In our study there was a visual improvement in 100% of cases. The complications of Nd:YAG laser therapy was very minimal to there was loss of ECD after the laser procedure, no significant change was found in the CCT, no rise of IOP in,no change in hexagonality and co-efficant of variation .

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