



## Central Macular Thickness Changes Following Laser Posterior Capsulotomy Measured By Optical Coherence Tomography

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### Abstract

**Background:** Posterior capsular opacification (PCO), also called 'secondary' or 'after' cataract, develops a few months to a few years over the clear posterior capsule after an uncomplicated cataract surgery that causes decreased vision. **Purpose:** To evaluate the impact of Neodymium-doped Yttrium Aluminum-Garnet (Nd: YAG) laser capsulotomy on the central macular thickness (CMT) by optical coherence tomography (OCT) in patients with opacified posterior capsule. **Patients and Methods:** This is a prospective clinical study conducted on 30 pseudophakic patients recruited from Luxor International Hospital and Beni-Suef University Hospital during the period from December 2018 through August 2019. Their age ranged from 40 – 70 years with a mean  $\pm$  SD of  $56.0 \pm 8.89$  years. There were 19 females (63.3%) and 11 males (36.7%). **Results:** There was highly statistically significant increase in CMT 1 week post YAGYAG laser than pre-YAGYAG with a mean thickness of  $253.80 \pm 14.03 \mu$  vs  $241.53 \pm 10.22 \mu$  respectively with a P-value  $< 0.001$ . Four weeks post YAGYAG, CMT decreased to  $247.27 \pm 12.54 \mu$  (P= 0.186) which is non significant. At 12 weeks post YAGYAG CMT decreased to  $243.27 \pm 12.69$  .with p-value  $< 0.001$  which is highly statistically significant. **Conclusion:** Increased CMT was reported as complication of YAG laser posterior capsulotomy. Although this is not clinically observed but follow up with OCT revealed these changes. However, this might not necessitate regular prophylactic treatment. **Keywords:** Central Macular Thickness - Laser Posterior Capsulotomy - Optical Coherence Tomography

## 1. Introduction:

Posterior capsular opacification (PCO) is predominantly caused by residual lens epithelial cells (LEC)s in the capsular bag after cataract surgery. Several surgical techniques have been attempted for the removal of these LECs at the time of lens extraction <sup>(1)</sup>. These techniques include aspiration of the anterior capsule epithelial cells using an extensive irrigation/aspiration system during cataract surgery <sup>(2)</sup>. ND: YAG laser capsulotomy appears to be a safe and efficient method of treating capsular opacification; it improves visual acuity in all cases, if different ocular pathology had not influenced.

Cystoid macular edema is a common non-specific inflammatory response of the macular area which may distort central vision because the macula holds tightly packed cones that provide sharp clear central vision. It occurs after intraocular surgical procedures, trauma, and a variety of other inflammatory conditions affecting the retina.

Macular edema after YAGYAG laser capsulotomy is caused by movement and damage in the vitreous cavity and release of inflammatory mediators due to the damage of blood-aqueous barrier. Cystoid macular edema may be diagnosed by an unexplained loss of vision, and by ophthalmoscope. Several imaging instruments which are commercially available for measurement of macular thickness. These include the retinal thickness analyzer, confocal

scanning laser ophthalmoscope, and optical coherence tomography (OCT).

OCT is the most commonly used imaging technology for examination of the macula because it is the only instrument that provides direct visualization of the layered retinal structures <sup>(3)</sup>.

The severity of macular edema is less when a total energy level less than 80 microjoules is used <sup>(4)</sup>.

## 2. Patients and Methods

- **Type of study:** a prospective study.
- **Study setting:** this study involved patients visiting outpatient clinic
- **Study period:** This study was conducted in the period from December 2018 till August 2019.
- **Sampling Method:** None
- **Sample size:** Thirty pseudophakic eyes of thirty different patients.

### Patient's population

#### Inclusion criteria:

- **Age of patients:** from 40 to 70 years with a mean of 55 years.
- **Gender:** both genders were included
- **Time after cataract surgery:** at least 6 months after cataract surgery.
- PCO after uneventful cataract surgery
- A healthy anterior segment appearance on examination with slit-lamp.

#### Exclusion Criteria:

- Patients with corneal opacities, glaucoma, retinopathy, maculopathy, and optic neuropathy.
- Patient with past history of uveitis.

- Cases in which there was a history of definite trauma were excluded.
- Complications during cataract surgery or the post-operative period
- An abnormal measurement of the macula or the presence of epiretinal membrane on OCT preoperatively
- Dense PCO interfering with OCT.

#### **Ethical Considerations:**

- A verbal informed consent was taken from all subjects participating in this study.
- All the individuals included in the study were informed about the procedures regarding the study and were 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 would be treated with confidentiality.

#### **Study Procedures:**

- 1. Best corrected visual acuity (BCVA):** Landolt's broken ring chart was used
- 2. Anterior segment examination:** Slit lamp biomicroscopy was done for examination of the anterior segment and diagnosis of PCO.
- 3. Fundus examination:** Visualization of the posterior pole was assessed by examining the optic disc and macula using a + 90D lens.
- 4. Investigations:**
  - a. Full mydriasis was obtained with topical tropicamide 1%.

- b. Measurement of the central macular thickness (CMT) was done to all patients preoperatively by OCT.

#### **5. Surgical technique:**

- a. Topical anesthesia was achieved using benoxinate hydrochloride 0.4% eye drops.
  - b. A capsulotomy contact lenses (double aspheric Abraham capsulotomy lens).
  - c. Lubricating gel (methyl cellulose) was used during the capsulotomy.
  - d. Ophthalmic Nd: YAG laser (Ellex Super Q YAG photodisruptor, Ellex Medical Pty Ltd, Australia).
  - e. The posterior capsulotomies were performed in a single session.

- 6. Follow up:** Patients were examined on the second day post operatively for detection of any complications.

- 7. Measurement of central macular thickness by OCT at one week, one month and three months from the time of posterior capsulotomy.**

#### **Statistical Analysis**

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23. The quantitative data were presented as mean, standard deviations and ranges when their distribution found parametric.

Also qualitative variables were presented as number and percentages.

While comparison between more than two paired groups with quantitative data and

parametric distribution were done by using **repeated measure ANOVA** test.

### 3. Results :

**Table (1):** Demographic and characteristics of the studied cases

|     |         | No. = 30     |
|-----|---------|--------------|
| Age | Mean±SD | 56.00 ± 8.89 |
|     | Range   | 40 – 70      |
| Sex | Female  | 19 (63.3%)   |
|     | Male    | 11 (36.7%)   |
| Eye | Right   | 14 (46.7%)   |
|     | Left    | 16 (53.3%)   |

This study was conducted on 30 patients admitted from Luxor International Hospital and Beni-Suef University Hospital during the period from December 2018 to August 2019. Their age ranged from 40 – 70 years with mean ± SD of 56.0 ± 8.89. There were 19 females (63.3%) and 11 males (36.7%).

**Table (2):** BCVA at the different times of measurement

| BCVA                      |         | No. = 30    |
|---------------------------|---------|-------------|
| Pre YAG                   | Mean±SD | 0.38 ± 0.15 |
|                           | Range   | 0.15 – 0.8  |
| BCVA 1 week post YAGYAG   | Mean±SD | 0.48 ± 0.19 |
|                           | Range   | 0.2 – 0.8   |
| BCVA 4 weeks post YAGYAG  | Mean±SD | 0.62 ± 0.23 |
|                           | Range   | 0.2 – 1     |
| BCVA 12 weeks post YAGYAG | Mean±SD | 0.73 ± 0.19 |
|                           | Range   | 0.3 – 1     |

As regard BCVA There was significant improvement of BCVA (Log MAR) postoperatively (P<0.001.) The preoperative measurements ranged from 0.15 to 0.8 with the mean ±SD of 0.38 ± 0.15. At the first week postoperative, BCVA ranged from 0.2 – 0.8 with a mean of 0.48 ± 0.19. At 4 weeks, the BCVA ranged from 0.2 – 1 with a mean of 0.62 ± 0.23. At 3 months, the BCVA ranged from 0.3 – 1 with a mean of 0.73 ± 0.19.

**Table (3):** CMT at the different times of measurement

| CMT                  |           | No. = 30       |
|----------------------|-----------|----------------|
| Pre YAGYAG           | Mean ±S D | 241.53 ± 10.22 |
|                      | Range     | 217 – 259      |
| Week post YAGYAG     | Mean±SD   | 253.80 ± 14.03 |
|                      | Range     | 219 – 275      |
| 4 weeks post YAGYAG  | Mean±SD   | 247.27 ± 12.54 |
|                      | Range     | 228 – 270      |
| 12 weeks post YAGYAG | Mean±SD   | 243.27 ± 12.69 |
|                      | Range     | 220 – 263      |

As regard CMT, the preoperative CMT ranged from 217 – 259 with mean ±SD of 241.53 ± 10.22, At one week post YAG laser, CMT ranged from 219 – 275 with mean ±SD of 260.64±22.50, At one week postoperative CMT ranged from 211.0 to 336.0 with mean SD of 253.80 ± 14.03. At one month post-operative CMT ranged from 228 – 270 with mean ±SD of 247.27 ± 12.54. At three months post YAG laser CMT ranged from (220 – 263) with mean±SD 243.27 ± 12.69.

**Table (4):** Comparison between BCVA pre YAGYAG, 1 week post YAGYAG, 4 weeks post YAGYAG and 12 weeks post YAGYAG

| BCVA      | Pre YAGYAG  | 1 week post YAGYAG | 4 weeks post YAG | 12 weeks post YAG | Test value• | P-value | Sig. |
|-----------|-------------|--------------------|------------------|-------------------|-------------|---------|------|
|           | No. = 30    | No. = 30           | No. = 30         | No. = 30          |             |         |      |
| Mean ± SD | 0.38 ± 0.15 | 0.48 ± 0.19        | 0.62 ± 0.23      | 0.73 ± 0.19       | 108.449     | 0.000   | HS   |
| Range     | 0.15 – 0.8  | 0.2 – 0.8          | 0.2 – 1          | 0.3 – 1           |             |         |      |

**P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)**

The previous table shows that there was highly statistically significant increase in BCVA 1 week post YAGAG than pre YAGYAG with mean of 0.48 ± 0.19 vs 0.38 ± 0.15 with p-value < 0.001. Also 4 weeks post YAG BCVA were increased to 0.62 ± 0.23 than 1 week with p-value < 0.001. At 12 weeks post YAG BCVA were increased to 0.73 than 4 weeks with p-value < 0.001.

**Table (5):** Comparison between CMT pre YAG, 1 week post YAG, 4 weeks post YAG and 12 weeks post YAG

| CMT       | Pre YAG        | 1 week post YAG | 4 weeks post YAG | 12 weeks post YAG | Test value | P-value | Sig. |
|-----------|----------------|-----------------|------------------|-------------------|------------|---------|------|
|           | No. = 30       | No. = 30        | No. = 30         | No. = 30          |            |         |      |
| Mean ± SD | 241.53 ± 10.22 | 253.80 ± 14.03  | 247.27 ± 12.54   | 243.27 ± 12.69    | 48.387     | 0.000   | HS   |
| Range     | 217 – 259      | 219 – 275       | 228 – 270        | 220 – 263         |            |         |      |

**P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value < 0.01: highly significant (HS)**

The previous table shows that there was highly statistically significant increase in CMT one week post YAG than pre YAG with mean of  $253.80 \pm 14.03$  vs  $241.53 \pm 10.22$  with p-value < 0.001. BUT in 4 weeks post YAG CMT were decreased (improved) to  $247.27 \pm 12.54$  than 1 week with p-value < 0.186 which is non significant. At 12 weeks post YAG CMT were decreased (improved) to  $243.27 \pm 12.69$  than 4 weeks with p-value < 0.001 which is highly statistically significant.

**Table (6):** Comparison between mean difference of BCVA 1 week, 4 weeks and 12 weeks

| Mean difference (BCVA)      | No. = 30        |
|-----------------------------|-----------------|
|                             | Mean±SD         |
| Pre YAG Vs 1 week post YAG  | $0.11 \pm 0.11$ |
| Pre YAG Vs 4 week post YAG  | $0.25 \pm 0.10$ |
| Pre YAG Vs 12 week post YAG | $0.35 \pm 0.12$ |

AS regards BCVA, the mean difference one week post YAG Vs pre YAG was 0.11, four weeks post YAG Vs preYAG was 0.25 and the mean difference three months post YAG Vs preYAG was 0.35. So there were increasing in the mean difference which is statistically significant.

**Table (7):** Comparison between mean difference of CMT 1 week, 4 weeks and 12 weeks

| Mean difference (CMT)      | No. = 30         |
|----------------------------|------------------|
|                            | Mean±SD          |
| Pre YAG Vs 1 week post YAG | $12.27 \pm 7.04$ |
| Pre YAG Vs 4 week post YAG | $5.73 \pm 6.11$  |

|                             |             |
|-----------------------------|-------------|
| Pre YAG Vs 12 week post YAG | 1.73 ± 7.00 |
|-----------------------------|-------------|

AS regards CMT, the mean difference one week post YAG Vs pre YAG was 12.27, four weeks post YAG Vs preYAG was 5.73 and the mean difference three months post YAG Vs preYAG was 1.73. So there were decreasing (improvement) in the mean difference.

#### 4. Discussion:

This study conducted on 30 patients admitted from Luxor international hospital and Beni-Suef university hospital in the period from December 2018 to August 2019. Their age ranged from 40 – 70 years with mean ± SD of 56.0 ± 8.89. There were 19 females (63.3%) and 11 males (36.7%).

- The mean pre-procedural BCVA was 0.38 ± 0.15 log MAR units
- The mean post-procedural BCVA was 0.48 ± 0.19 log MAR units at the first week, 0.62 ± 0.23 log MAR units after four weeks and 0.73 ± 0.19 log MAR units after three months.

In the current study there was improvement in BCVA postoperatively which was highly statistically significant (p-value < 0.001) increase one week post YAG than pre YAG with mean of 0.48. In addition, 4 weeks post YAG BCVA increased to 0.62 than one week. At twelve weeks post YAG BCVA were increased to 0.73 than four weeks.

This was consistent with what was proved by other studies done by <sup>(5)</sup> whose study was on 100 eyes of 100 patients, <sup>(6)</sup> whose study was on 160 eyes, 95% of the patients had visual function improvement, In the study done by <sup>(7)</sup>, when comparing postoperative values at one week, to corresponding preoperative value,

there was statistically significant improvement of BCVA up to 0.00 Log MAR in majority of patients consistent with decrease of all postoperative numerical values of BCVA (Log MAR) but unlike our study there was no statistically changes in values from one week postoperative till three months.

As regards CMT In the current study we measured the central macular thickness before YAG laser capsulotomy and it was 241.53 ± 10.22µm, there was a statistically significant increase in central macular thickness after one week (253.80 ± 14.03 µm).

The mean macular thicknesses was decreased postoperatively at four weeks with mean (247.27 ± 12.54 µm) which was not statistically significant and decreased at three months with mean (243.27 ± 12.69) which was highly statistically significant.

In <sup>(7)</sup>, when comparing postoperative values of CMT with preoperative values they found highly significantly increase in CMT at one week post laser. Also there was significant increase in CMT one month values at three months showed non-significant changes when compared to preoperative values but in

our study there was decrease in CMT after one and three months.

<sup>(4)</sup>, study studied 30 patients, they divided the patients into two groups as regard to the total laser energy was used; less than 80 mJ and more than 80 mJ. They noticed an increase in CMT in both groups by OCT which was more in the group with total energy more than 80 miljoules.

<sup>(8)</sup> divided the patients into two groups according to capsulotomy size (group 1<3.9mm, group 2>3.9mm). CMT assessed by OCT after 1, 4 and 12 weeks, and they found significant increase in CMT at the first week in both groups. They observed that there was no significant difference in CMT after 4 and 12 weeks compared to pre laser values but in our study there was significant difference after 12 weeks.

As regard complications occurred in our study, IOL pittings occurred in one patient out of 30 patients (3.33%), while <sup>(9)</sup> noted 11.7% significant marks on IOL during laser capsulotomy in 342 eyes. Neither retinal breaks nor detachment after YAG laser posterior capsulotomy was found, however <sup>(10)</sup>; noticed that retinal breaks and detachment occurred after YAG laser capsulotomy, thier study was to determine the 5-year incidence of retinal breaks and retinal detachment after Nd: YAG laser posterior capsulotomy so there was limitation of the current study as the follow up was for twelve weeks only, so long follow up was

done by <sup>(11)</sup> and the incidence of RD was 0% at 6 months, 0% at 12 months, and 0.5% at 24 months, twenty-one months after Nd: YAG capsulotomy, 1 eye developed an RD that occurred as the result of a horseshoe tear that reopened.

## 5. Conclusion:

Posterior capsular opacification (PCO) is the most frequent complication of cataract surgery. Advances in surgical techniques, intraocular lens materials and designs have reduced the PCO rate, but it is still a significant problem <sup>(12)</sup>.

Visually significant posterior capsular opacification is the most common late complication of uncomplicated cataract surgery. It occurs in 50% of cases within 2-3 years after surgery <sup>(13)</sup>.

Nd: YAG laser capsulotomy is the standard treatment for PCO. It is noninvasive, valuable, out-patient procedure, quick relatively secure technique. It clears visual axis from opacification so visual functions improved directly after performing the procedure. This method is credible but it has some complications.

Increased CMT was reported as complication of YAG laser posterior capsulotomy. Although this not clinically observed but follow up with OCT revealed this changes. However, this might not necessitate regular prophylactic treatment.



Our study conducted on 30 patients. Their age ranged from 40 – 70 years with mean  $\pm$  SD of  $56.0 \pm 8.89$ . They were 19 females (63.3%) and 11 males (36.7%).

There was highly statistically significant increase in BCVA 1 week post YAG than pre YAG with mean of  $0.48 \pm 0.19$  vs  $0.38 \pm 0.15$  with p-value  $< 0.001$ . Also 4 weeks post YAG BCVA were increased to  $0.62 \pm 0.23$  than 1 week with p-value  $< 0.001$ . At 12 weeks post YAG BCVA were increased to 0.73 than 4 weeks with p-value  $< 0.001$ .

There was highly statistically significant increase in CMT one week post YAG than pre YAG with mean of  $253.80 \pm 14.03$  vs  $241.53 \pm 10.22$  with p-value  $< 0.001$ . BUT in 4 weeks post YAG CMT were decreased (improved) to  $247.27 \pm 12.54$  than 1 week with p-value  $< 0.186$  which is non significant. At 12 weeks post YAG CMT were decreased (improved) to  $243.27 \pm 12.69$  than 4 weeks with p-value  $< 0.001$  which is highly statistically significant.

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