A Randomised Comparison of Two Laser Iridotomy Techniques in Patients of Primary Angle Closure Disease with Absent Iris Crypts

Manav Deep Singh, Pradeep Aggarwal, Nidhi Sharma
Post Graduate Institute of Medical Education & Research, Dr Ram Manohar Lohia Hospital, New Delhi, India

Abstract

**Purpose:** Patients with absent iris crypts are the most challenging cases for performing laser peripheral iridotomy. This study was conducted on patients of primary angle closure disease belonging to this group to find out the difference in the quantum of energy and number of attempts required to achieve optimum peripheral iridotomy by sequentially using double frequency Nd:YAG and Nd:YAG laser versus Nd:YAG laser alone.

**Methods:** Forty eyes of 40 patients of 35 years or more, with primary angle closure disease and absent iris crypts, in whom laser peripheral iridotomy (LPI) was indicated, were prospectively randomized into two groups. Patients in group one sequentially underwent double frequency Nd:YAG & Nd:YAG laser and group two underwent Nd:YAG laser alone. Follow up was done one hour, three hours, one day and one week post laser. Any rise of IOP of > 8 mmHg from base line or an absolute figure of 30 mmHg at any visit was considered significant. Post laser topical loteprednol etabonate 4 times per day for one week and pilocarpine nitrate 2% eye drops twice a day for five days were used in all cases. Statistical testing was conducted with the statistical package for the social science system (SPSS) version 17.0.

**Results:** Group one had 3 male and 16 female patients whereas group two had 9 and 12 male and female patients respectively. Nd:YAG energy required in group one (n=19) was 48.79 ± 19.41 mJ and in group two (n=21) was 88.81 ± 37.36 mJ (p<0.001). In group one, an optimum LPI could be achieved in single sitting in 18 out of 19 patients. In group two, out of a total of 21 patients, 8 (38.1%) required one sitting, 11 (52.4%) required two sittings and two (9.5%) required three sittings to achieve patent PI. The difference was highly significant (p<0.001). The reasons for multiple sittings included haemorrhage (n=8) and iris chafing (n=8).

**Conclusion:** Sequential use of the double frequency Nd:YAG followed by Nd:YAG laser is superior to YAG laser alone in terms of required energy and number of sittings for the purpose of doing laser peripheral iridotomy among patients with absent iris crypts.

**Keywords:** laser peripheral iridotomy, angle closure glaucoma, iris crypts, primary angle closure disease.

Introduction

Glaucoma is the most common cause of irreversible blindness worldwide. Incidence of Primary angle closure glaucoma (PACG) is higher among Asians than Europeans and Africans. Laser peripheral iridotomy (LPI) is indicated for the entire spectrum of angle closure disease with pupillary block. This can be done by either using double frequency Nd:YAG, Nd:YAG laser or combination of both. The authors, in a pilot study, observed that energy requirement for LPI depended on the presence or absence of iris crypts and not on age, sex or stage of glaucoma. Sequential argon and YAG laser peripheral iridotomy has been shown to have lower risk of hyphema and IOP (intraocular pressure) rise as compared to use of Nd:YAG laser alone among Asians. However, there are no published reports, to the best of our knowledge, that mentions the presence or absence of iris crypts as a determinant factor for the quantum of energy required to achieve patent peripheral iridotomy (PI). Literature is, practically, silent on the energy requirements for PI among patients of primary angle closure disease (PACD) with absent iris crypts; rather it mentions only thick or thin irides. Eyes of Indian patients suffering from PACD without crypts constitute a substantial number and pose a significant challenge. Very few authors have reported specific factors which affect the energy required for peripheral iridotomy in Asian dark irides. Hence, with this lacuna in literature, this study was planned to find out the benefits, if any, of sequential technique over Nd:YAG laser alone in terms of requirement of energy and number of sittings in patients with absent iris crypts.

Materials And Methods

This study was conducted according to declaration of Helsinki. A written informed consent was obtained from all the patients prior to enrolment and the institutional review board approved the study. Indications for LPI were PACG and primary angle closure (PAC) along with primary angle closure suspects (PACS) with critically narrow angles and symptomatic patients. Patients with primary angle closure disease in whom iris crypts were absent in the superior half of the iris, in whom PI was indicated, were recruited out of the patients visiting outpatient department (OPD) of our institute from 1st November 2013 to 20th March 2015. Patients with any corneal disease, those in acute attack of angle closure glaucoma or with signs of active/healed intraocular inflammation or ocular trauma were excluded. Forty eyes of 40 patients were included in the study. If both eyes were eligible; only one eye, selected by randomization using
envelope technique, was included in the study. Pre-laser work up included detailed history, systemic examination and ocular examination. Ophthalmic examination comprised of visual acuity assessment using Snellen’s chart, slit lamp biomicroscopy, gonioscopy and un-dilated fundus examination. Peripheral iridotomy was performed using Zieiss laser model VISULAS II plus (this laser is a combined unit of double frequency YAG and Nd:YAG lasers). One hour prior to laser, baseline IOP was recorded using well calibrated Goldmann applanation tonometer (GAT) followed by instillation of pilocarpine nitrate 2% eye drops every 20 minutes till beginning of the procedure. Topical proparacaine hydrochloride 0.5% was instilled immediately before the procedure. Abraham laser iridotomy lens with 2% hydroxypropyl methylcellulose as coupling agent was used. Forty recruited patients were randomized into one of the two groups using lottery method. In group one, double frequency Nd:YAG laser was used to create an area of iris stretch at the intended iridotomy site by applying spots in a circumferential manner (Figure 1) with a spot size of 100 μ, duration 0.1 sec and energy 100-250 mW in superior nasal or superior temporal quadrant. This was done in an effort to stretch the iris to create a central area of iris thinning. This was followed by use of Nd:YAG laser to create an optimally sized iridotomy. In group two, Nd:YAG laser alone was used with pulses/bursts of variable power to achieve patent iridotomy using minimum possible energy (Figure 2). In all cases, total YAG energy as well as cumulative energy (double frequency Nd:YAG and Nd:YAG) and number of sittings required was recorded. Reasons for abandonment of procedure were also noted. Post laser treatment, in both groups, included topical loteprednol etabonate 0.5% eye drops 4 times per day for one week starting immediately following laser and pilocarpine nitrate 2% eye drops twice a day for five days. Selection of topical loteprednol etabonate 0.5% eye drops as anti-inflammatory agent was due to the fact that it is a reasonably efficacious steroid with minimal tendency to cause rise in IOP. Considering the low incidence of IOP rise following anterior segment YAG procedures in another study from the same institution, use of ocular hypotensives drugs (in addition to pilocarpine, which was essentially used to keep iris stretched to avoid blockage of PI) was considered only for selected cases with rise of IOP. Follow up of patients was carried out at 1 hour, 3 hours, 1 day and 1 week post laser. Any rise of IOP of > 8 mmHg from base line or an absolute figure of 30 mmHg at any visit was considered significant in commensuration with previous studies. As per the protocol, cases of significant rise of IOP were advised to undergo routine medical management of glaucoma. Primary outcome variables included total YAG energy consumed in one or more sittings and the total number of sittings required to achieve optimum laser iridotomy. Secondary outcome variables included intraocular pressure (IOP) and amount of inflammation assessed clinically. One week post laser, after confirming the patency of peripheral iridotomy, gonioscopy was done to look for the opening of the angle, changes in the amount of pigmentation and appearance of new peripheral anterior synechiae. This was followed by dilated examination of the retina.

Statistical testing was conducted with the statistical package for the social science system (SPSS) version 17.0. The comparison of normally distributed continuous variables between the groups was performed using Student’s t test. Nominal categorical data between the groups were compared using Chi-squared test or Fisher’s exact test as appropriate. For all statistical tests, a p value less than 0.05 was taken to indicate a significant difference.

Results
Nineteen patients underwent laser PI sequentially using double frequency Nd:YAG followed by Nd:YAG laser (Group 1) and 21 underwent Nd:YAG laser alone (group 2) (Table 1).

Group one had 3 male and 16 female patients whereas group two had 9 and 12 male and female patients respectively. Number of patients with age < 50 years, 51-60 years and

| Patients’ Group | Percentage | Number |
|-----------------|------------|--------|
| Group one       | 47.5 %     | 19     |
| Group two       | 52.5 %     | 21     |
Table 2: Comparison of mean total YAG* energy (mJ), number of laser shots and laser sittings required in two groups

| Group       | Group one (n=19) | Group two (n=21) |
|-------------|------------------|------------------|
| Mean total YAG* energy (milli Joules) | 50.55            | 88.81            |
| Mean number of laser shots | 9.53            | 22.1             |
| No. of laser sittings |                   |                   |
| 1           | 18 (94.7 %)      | 08 (38.1 %)      |
| 2           | 01 (5.3 %)       | 11 (52.4 %)      |
| 3           | 00 (0.0 %)       | 01 (9.5 %)       |

*YAG: Yttrium aluminium garnet laser

The average total Nd:YAG energy required to achieve optimum peripheral iridotomy was significantly more in group two compared to group one (*p ≤ 0.001*) (Table 2). The mean number of laser shots required to achieve patent iridotomy in group two was significantly higher than group one with *p < 0.001* (Table 2). The difference in requirement of number of sittings between the two groups was also statistically significant (*p < 0.001*) (Table 2).

In group one, an optimum LPI could be achieved in single sitting in 18 out of 19 patients. In group two, 8 (38.1%) patients required one sitting, 11 (52.4%) required two sittings and two (9.5%) required three sittings to achieve patent PI. The difference was highly significant (*p < 0.001*). Patients who required three sittings had iris chafing as the cause of each of the two postponements. Thus, out of a total of 16 postponements, eight were due to haemorrhage and eight were due to iris chafing (Table 3).

Significant fall in IOP at 1 day and 1 week (*p= 0.002, p < 0.001*) post laser was noted in group one. Statistically significant fall in IOP at 3 hours, 1 day and 1 week in Group two was observed (Table 4). A note of aqueous cells was made and their difference in two groups was found to be insignificant at one hour post laser (*p= 0.023*). However, the difference was statistically significant at 3 hours (*p=0.011*) (Table 5) and one week post laser (*p=0.002*) when aqueous cells were more in Group two. Similar trend was noticed in aqueous flare among two groups and showed more inflammation in group two patients. Morphology of the opening of PI was also found to be different in the two groups, it was slit shaped in the cases in which only Nd:YAG laser was used and was more rounded among patients who underwent sequential technique (Figure 2 & 3).

Table 3: Cause of multiple sitting for peripheral iridotomy

| Patients | First postponement | Second postponement |
|----------|--------------------|---------------------|
|          | Iris haemorrhage   | Chafing of iris     | Iris haemorrhage   | Chafing of iris     |
| Group one (n=19) | 1                  | 0                   | 0                   |
| Group two (n=13)  | 7                  | 6                   | 0                   | 2                   |
| Total (n=14)       | 8                  | 6                   | 0                   | 2                   |

Table 4: Mean intraocular pressure following laser PI in Group one and Group two

| Group   | IOP (mmHg) Mean ± SD | Difference from baseline (p value) | IOP (mmHg) Mean ± SD | Difference from baseline (p value) |
|---------|----------------------|-----------------------------------|----------------------|-----------------------------------|
| Group I | 10.05 ± 5.05         |                                   | 22.48 ± 4.41         |                                   |
| Group II| 20.21 ± 6.88         | -0.158 (1.000)                   | 21.67 ± 4.53         | +0.810 (1.000)                    |
| Group I | 17.79 ± 3.92         | -2.263 (0.287)                   | 20.52 ± 3.89         | +1.952 (<0.003)                   |
| Group II| 20.05 ± 5.05         |                                   | 18.62 ± 3.17         | +3.857 (<0.001)                   |
| Group I | 15.74 ± 3.57         | -4.316 (<0.001)                  | 17.29 ± 4.03         | +5.190 (<0.001)                   |

Table 5: Comparison of Clinically assessed Aqueous Cells between groups three hours post laser

| Aqueous cells | Group one | Group two |
|--------------|-----------|-----------|
| Number       | Percentage | Number     | Percentage | Number     | Percentage |
| 0            | 73.7 %     | 14        | 42.9 %     | 09        | 57.3 %     | 23        |
| 1+           | 21.1 %     | 04        | 9.5 %      | 02        | 15 %       | 06        |
| 2+           | 5.3 %      | 01        | 47.6 %     | 10        | 27.5 %     | 11        |

Discussion

Laser peripheral iridotomy can be made by photocoagulative lasers, photodisruptive lasers or a combination of both. Sequential double frequency Nd:YAG (or its argon equivalent) and Nd:YAG lasers have been used as a standard mode of treatment for peripheral iridotomy in Asian eyes by some workers. Very few studies in the literature have categorically shown superiority of sequential technique over Nd:YAG laser alone. In Asian eyes with thicker irides, sequential argon laser peripheral iridotomy has been shown to have lower risk of hyphema and rise of intraocular pressure.

In the present study, total YAG energy required to achieve patent PI in sequential double frequency Nd:YAG laser and Nd:YAG was much lower than Nd:YAG alone group which supports findings of other studies. Don Julian et al reported that the median pulsed YAG power in the YAG alone treatment was 37.5 mJ and in the sequential treatment group was 22.5 mJ. In another study by Tony Ho et al it was observed that only one third of YAG energy was required if iris had been made thin by use of argon laser prior to YAG. In reverse, if we look at the total combined energy consumed (double frequency YAG + YAG) in group one, and compare it...
with group two then the energy consumed in the sequential group (1.938 ± 1.004 J) is much more than the YAG group (0.0888 ± 0.0378 J). However, direct comparison of total energies used between Nd:YAG and sequential group is not justified because in group one, the use of energy is far more by virtue of double frequency laser. The double frequency Nd:YAG laser is a continuous wave laser and this has a thermal effect (photoagulative energy) as compared with Nd:YAG which is short pulsed laser, photo-disruptive in nature and leads to disruption of target tissue by delivering very high power to very small zone in highly localized focal plane. It may be noted that double frequency YAG energy is not clinically so significant. This is because this energy is not responsible for secondary rise of IOP, trabeculitis, lenticular opacities or any macular damage. These complications are more frequently caused by photo-disruptive energy which is delivered by YAG laser. This suggests that it is the YAG and not the total energy which is significant in terms of complications. However, it does result in difference in the morphology of opening as observed in our study (Figure 1 & 2) and also reported previously. In addition, less number of visits required in sequential technique, reduces inconvenience as well as financial burden of patients.

Tony Ho et al reported 100% success rate in a single sitting, in achieving patent iridotomy in sequentially used combination of argon and YAG laser in a single sitting. Don Julian et al reported 30 patients who underwent bilateral Nd:YAG laser iridotomy, with one eye randomly assigned to pre-treatment with double frequency Nd:YAG laser. All iridotomies were patent in sequential pre-treatment group in a single sitting while 2/30 cases in the Nd:YAG laser group required more than one sitting. In our study the difference was more marked (Table 3). It may not be forgotten that multiple laser sittings for performance of peripheral iridotomy also lead to more inflammation and related complications like rise of intraocular pressure, posterior synechiae, chances of cataract formation and macular changes. The laser peripheral iridotomy was abandoned due to iris haemorrhage in seven patients in group two as compared to only one patient in group one and due to iris chaffing in six patients in group two. De silva et al reported 2/30 patients in whom LPI was abandoned and both were due to iris haemorrhage.

Several studies have reported short term complication like rise in IOP following laser iridotomy. This rise of IOP, as shown in above studies, was not consistent with our results where we found significant fall in mean IOP post laser at different study points. Only one randomized trial recorded results similar to ours. de Silva et al reported mean IOP decreased from 19.0 mm Hg to 14.4 mmHg post laser in Nd:YAG laser group and from 19.8 mmHg to 13.8 mmHg post laser in the sequential treatment group. Both were significantly lower than the pre laser iridotomy values (p<0.001). There are some known factors which could affect the intraocular pressure including use of YAG laser energy causing inflammation and rise of IOP post laser. The fall of intraocular pressure could possibly be due to use of pilocarpine eye drop and/or opening of angle due to a patent PI. It was noticed that the maximum fall of intraocular pressure was observed at one week. However, at one week post laser, in our study, there was no effect of pilocarpine since pilocarpine had been stopped after five days post laser. Thus by one week the effect of pilocarpine had, practically, been washed out. Moreover, this tendency of fall of IOP was seen in both the groups. It is prudent to expect that secondary rise of IOP would have already finished by this time. This conclusion is similar to other published studies. We also observed that the use of double frequency Nd:YAG laser followed by Nd:YAG laser in sequential manner not only reduced the requirement of YAG energy significantly (p=0.001) but also resulted in much less inflammation in the form of cells and flare. However, there was no anterior chamber flare/cell observed at one week post laser in any case. Therefore, this fall of IOP appears to be, most likely, caused by opening of the angle, secondary to laser PI. This study suggests that the sequential use of the double frequency Nd:YAG followed by Nd:YAG laser is superior to YAG laser alone for the purpose of doing PI in cases with absent iris crypts. In view of the review of literature and the findings of present study, it can be stated that it is the absence of crypts rather than colour of iris which may be considered as a criterion for labelling a significantly thick iris. It may be further concluded that in the subset of eyes with absent iris crypts, in case LPI is required, sequential use of combined argon (or double frequency YAG) and Nd:YAG rather than Nd:YAG laser alone should be the preferred mode of treatment to minimize the requirement of energy, sittings and related complications. The limitations of our study included small sample size, essential use of pilocarpine which could affect the IOP and the difference in male: female ratio in two groups; although it was not statistically significant.

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**Original Article**

**Corresponding author:**

Nidhi Sharma

MS, DNB

Senior Resident, Postgraduate Institute of Medical Education and Research.

Dr. Ram Manohar Lohia Hospital, New Delhi , India

Email: smilingnidhi6@gmail.com

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