Title of the article: Effect of Nd:YAG Laser Goniopuncture Timing on the Long-term Efficacy of Non-penetrating Deep Sclerectomy

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Abstract

Purpose To report on impact of Nd:YAG laser goniopuncture (LGP) timing on hypotensive efficacy of deep sclerectomy (DS) for open-angle glaucoma (OAG).

Methods 228 patients who underwent DS followed by LGP between January 2010 and December 2013, (follow up – 5 years) were enrolled into a single-center, retrospective, non-randomized, consecutive study. Subjects were divided into two groups (1 – delayed LGP, n=116; 2 – early LGP, n=112). Intraocular pressure (IOP), ultrasound biomicroscopy (UBM) values, DS and LGP intraoperative and postoperative complications were recorded. The criteria for early LGP were higher density and increased thickness of the Trabeculo-Descemet membrane (TDM), as well as decreased height of the intrascleral channel and the height of the scan by UBM monitoring. IOP elevated above the target values was also a criterion in the delayed LGP group. Complete success was defined as IOP ≤ 15 mm Hg.

Results LGP was performed 3.46±1.9 (1.5-6.7) months after in group 1, 1.12±0.08 (0.9-1.5) months after in group 2. IOP lowered from 18.5±4.7 to 14.2±4.7 mm Hg in group 1 and from 15.7±4.1 to 12.1±1.9 mm Hg in group 2. Kaplan-Meier survival curve analysis showed a significant difference between groups for the target IOP ≤ 15 mm Hg (68.07% and 92.59% after 12 months, 40.7% and 75.8% after 24 months, 15.2% and 48.93% after 36, 48, 60 months respectively) p=0.0001.

Conclusion Early LGP after DS excludes TDM influence on further formation of intrascleral cavity and outflow pathways demonstrating more pronounced hypotensive success in a long-term follow-up period.

Key words: Deep sclerectomy, Nd:YAG laser goniopuncture, Glaucoma surgery, Trabeculo-Descemet membrane.
Introduction

Non-penetrating glaucoma surgery (NPGS) is used for surgical treatment of open-angle glaucoma (OAG). The basic principle of NPGS is creating filtration through a naturally occurring membrane to lower or stabilize intraocular pressure (IOP), minimizing early postoperative complications.[1,2]

NPGS includes 3 procedures: viscocanalostomy, canaloplasty and deep sclerectomy (DS). DS differs from viscocanalostomy and canaloplasty in that aqueous humor (AH) flows through the Trabeculo-Descemet’s membrane (TDM) into the intrasceral space and further to the filtering bleb.[3-5] DS is similar to trabeculectomy (TE), as both procedures are filtering and bleb-dependent; but in trabeculectomy AH passes from the anterior chamber to the subscleral space through a surgically created trabeculectomy hole and a basal iris coloboma.[1,2,5,6] In deep sclerectomy AH passes from the anterior chamber to the intrasceral space through a TDM lowering intraocular pressure (IOP) and reducing the risk of early postoperative complications that often occur in TE.[6-8]

Recent studies suggest that hypotensive efficacy of DS is less prolonged then in TE.[8,9] Unsatisfactory long-term outcomes in terms of complete hypotensive success are accompanied by using medication. Fibrosis, “clogging” with pigment, TDM inflammatory response, and iris incarceration at a low profile of the anterior chamber angle cause resistance to aqueous outflow.[2,10-12]

Nd: YAG laser goniopuncture (LGP) following DS is used to lower IOP and regulate aqueous outflow through the TDM without additional incisional surgery. However, the timing of LGP in relation to its efficacy and safety is still being discussed.

This study was conducted to prove safety and efficacy of early LGP and its impact on a long-term hypotensive outcome of DS.
Materials and methods

A single-center, retrospective, non-randomized, consecutive study was conducted and approved by the institutional review board of Irkutsk branch of S. Fyodorov «Eye Microsurgery» Federal State Institution. This study conformed to the Declaration of Helsinki and written informed consent was obtained from all patients.

This case series of DS followed by LGP in 228 OAG patients performed by one surgeon from 01.01.2010 to 31.12.2011 - group 1 (delayed LGP group), from 01.01.2012 to 31.12.2013 - group 2 (early LGP group). Groups were matched for age, glaucoma stages, number of topical hypotensive medication. All subjects underwent a full ophthalmic examination including visual acuity, Goldman applanation tonometry, gonioscopy, slit-lamp biomicroscopy, visual-field testing (Haag-Streit Octopus 600, Switzerland), fundus examination, fundus photography (TRC-50DX; Topcon, Japan), ultrasound biomicroscopy (UBM) (Opticon HiScan-2000, Italy). Intraoperative and postoperative complications (UBM and IOP values, as well as bleb manipulations) followed DS and LGP were recorded. UBM assessment (height (μm), thickness (μm), TDM density (%), intrascleral channel height (mm) and scan height (mm)) was performed 3 days after DS, before LGP, after LGP. Moorfield Bleb Grading System was used for biomicroscopic characteristics of the filtering bleb.[13]

OAG patients without preceding surgeries were included. Eyes with intraoperative TDM perforation, choroidal effusions, hemorrhage, narrow angle glaucoma, uveitis, trauma, preceding cataract or glaucoma operations, conjunctival scarring were excluded. Follow up period was five years in both groups.

Operative technique

The surgical technique in both groups was identical. The nuances of deep sclerectomy did not differ from the technique proposed by S. N. Fyodorov et al. in 1984.[14,15]

The surgery was performed under sub-Tenon's anesthesia. Mobilization and tilting of the eyeball was performed with transcorneal suture fixation with 8-0 nylon monofilament. Filtering bleb was formed fornix-based by a local conjunctival peritomy at the position from 11 to 1 o'clock. The conjunctiva and Tenon’s capsule was opened to expose the sclera. A gentle hemostasis was performed using a mild wet field bipolar cautery. A 4.0 X 4.0 mm superficial scleral flap was created with the tip of a no 11 steel blade. The scleral flap thickness corresponded to 1/3 of the scleral thickness. To exclude traumatization, the superficial flap was held by the assisting surgeon with curved tying forceps. A triangle of deep sclera leaving a margin of 0.5 mm limbus-based on each side was dissected, leaving a thin layer of sclera overlying choroid and exposed in the top area of this triangle. On reaching the anterior part of the dissection, where the scleral fibers were regularly oriented, parallel to the limbus, which corresponded the scleral spur. The scleral spur was also a remarkable landmark to identify the location of
Schlemm’s canal. The corneal stroma anterior to the trabecular meshwork and the TDM was removed creating a TDM window as a filtration site. The deep scleral flap was excised. Thin Schlemm’s canal endothelium and juxtacanalicular trabeculum membrane were peeled with the small blunt forceps. Thus, TDM Window was approximately 3.0 mm width and 1.0 – 1.5 mm height. At this stage, AH was seen percolating through the remaining TDM into the scleral space. Then the superficial scleral flap was repositioned and sutured in the scleral bed with 10/0 nylon sutures. A filtering bleb was formed using buried corneal conjunctival sutures with 10/0 nylon sutures. A subconjunctival injection of 0.1 ml of 0.1% solution 5-fluorouracil (5-FU) mg/ml and 0.3 ml dexamethasone was given. Post-operative medication in both groups included topical application of antibiotic (fluoroquinolone solution 4 times daily, 10-14 days) and steroid (dexamethasone solution 0.1% 6 times daily, tapering over 4-6 weeks).

**Nd:YAG Laser goniopuncture**

The indications for performing early or delayed LGP were UBM data demonstrating TDM thickening, as well as decreased intrascleral channel and scan height in both groups. In group 1 the additional indication was the failure to meet the target IOP. LGP was performed using the neodymium-doped:yttrium-aluminium-garnet (Nd:YAG) laser (Visulas Yag III; Carl Zeiss Meditec, Jena, Germany) with a wavelength of 1064 nm and gonioscopy lens (Magna Gonio Laser Lens, USA) by the single shots technique 2 or 3 pulses per burst and with the energy levels of 3-5 mJ until the TDM was punctured ensuring functional consistency of micro-fistula. Pilocarpine solution 1% was instilled before the procedure to prevent iris incarceration. Laser gonioplasty was performed at narrow angles of the anterior chamber or pulling the iris root to the TDM window to avoid incarceration.

**Study outcomes**

The study was aimed to assess the efficacy and safety of early LGP following DS and long-term hypotensive efficacy of DS in relation to LGP timing.

IOP was checked 3 days after DS, before and after LGP, and 6, 12, 24, 36, 48, 60 months after the surgery. At every follow-up filtering bleb consistency, complications and bleb manipulations (needling revision, suturolises, massage, 5-FU injection) were recorded. To assess hypotensive efficacy of DS in relation to LGP timing, mean IOP values in wide time intervals were used. DS success rate was interpreted in accordance with the WGA consensus for fistulizing procedures.[16] Complete success for Kaplan-Meier survival curves was taken to be as maintaining IOP ≤ 15 mm Hg and a 20% decrease from the baseline, but not lower than 6 mm Hg without medication. Postoperative bleb manipulations were not considered a failure.
Statistical analysis

Statistical analyses were conducted with Statistica 10.0 (“Stat Soft Inc.”, USA). Descriptive statistics was applied for numerical and categorical data. Nonparametric data were analyzed by Mann-Whitney U test. Data were tested for normality using Shapiro-Wilks test. Categorical variables were evaluated using Chi-square test ($\chi^2$), numerical variables were evaluated using $t$ test. To evaluate long-term outcomes and the difference between groups, Kaplan-Meier analysis was performed (target postoperative IOP ≤ 15 mm Hg without medication). Kaplan Meier curves with 95% confidence intervals were calculated using Greenwood formula. The difference between survival curves was verified by Log-Rank, Gehan-Wilcoxon, Cox-Mantel tests. Cox-regression analysis was performed to assess the efficacy of LGP timing and UBM parameters on the long-term hypotensive efficacy of DS. Finally, the Cox regression analysis was performed to assess the impact of other potential variables and accurately analyze the impact of LGP on the long-term efficacy of DS in groups. All tests were two-sided with statistical significance set at $p < 0.05$.

Results

228 eyes with OAG that underwent LGP following DS were recruited into the study. The baseline characteristics are summarized in Table 1. Decision to LGP was based on UBM data, as well as on the IOP level.

Group 1 (delayed LGP group) included 116 eyes of 116 patients who underwent LGP when IOP elevated over the target level. Mean interval between DS and LGP was $3.46 \pm 1.9$ (1.5-6.7) months, IOP reduced from $18.5 \pm 4.7$ mm Hg to $14.2 \pm 4.5$ mm Hg ($p=0.0001$).

Group 2 (early LGP group), included 112 eyes of 112 patients who underwent LGP as an adjuvant procedure. Although IOP remained in normal range, UBM showed the narrowing of the intrascleral channel and the scan height lowering. Mean interval between DS and LGP was $1.12 \pm 0.08$ (0.9-1.5) months, IOP reduced from $15.7 \pm 4.1$ to $12.15 \pm 1.9$ mm Hg ($p=0.0001$). LGP timing after DS between groups was significantly different ($p=0.0001$). IOP before LGP was also initially significantly different ($p=0.001$).

Group characteristics, complications and interventions after LGP are presented in Table 2. Laser energy and pulse number depended on the TDM density. Mean number of laser energy in group 1 was $3.85 \pm 0.9$ mJ (2.7 to 5.0); in group 2 was $1.95 \pm 0.6$ mJ (1.6 to 2.3) ($p=0.0001$). Mean pulse number in group 1 was $9.2 \pm 1.6$ (8 to 12); in group 2 - $5.0 \pm 1.6$ (3 to 7) ($p=0.0001$). LGP was accompanied by a number of complications. Choroidal effusion was the most frequent complication and occurred in 8.6% in group 1 and 3.5% in group 2 ($p=0.0001$). Group 1 had significantly more needling procedures ($p=0.03$) and 5-FU injections ($p=0.02$) (Table 2).
UBM data are summarized in Table 3. There was no significant difference in TDM height, thickness and density in both groups 3 days after the operation (p=0.7). UBM monitoring before LGP revealed significant difference in TDM thickness and density (p=0.0001). Before LGP and after LGP there was a significant difference in intrascleral channel and scan height (p=0.0001). Further UBM monitoring was performed if needed (IOP decompensation, impaired AH outflow localization and treatment efficacy control).

Although there was no difference in IOP after DS, later it was reported in relation with LGP timing (Fig. 1). Postoperative IOP values were: 15.6±4.6 mm Hg (group 1) and 15.7±4.3 mm Hg (group 2) at 12 months (p=0.98), 16.7±4.3 mm Hg and 14.9±1.6 mm Hg at 24 months (p=0.004), 16.8±3.9 mm Hg and 14.5±3.2 mm Hg at 36, 48, 54, 60 months respectively (p=0.0001).

Long-term hypotensive efficacy was estimated using Kaplan-Mayer survival curves that revealed significant difference in IOP between groups in terms of complete hypotensive success. IOP ≤ 15 mm Hg without medication was maintained in both groups in 68.07% (95% confidence interval (CI) 64.8-80.4) and 92.59% (95% CI 66.9-99.4) at 12 months, 40.7% (95% CI 26.8-59.7) and 75.8% (95% CI 70.8-89.7) at 24 months, 15.2% (95% CI 10.1-23.5) and 48.93% (95% CI 30.1-67.5) at 36, 48, 60 months respectively (p=0.0001) (Fig. 2).

The median survival in group 1 occurred in 20 months, while the median survival in group 2 occurred in 36 months (p=0.0001). Difference between survival curves was reliable according to Gehan-Wilcoxon test (p=0.00004), Cox-Mantel test (p=0.00005), and Log-Rank test (p=0.0002).

Cox regression analysis was performed to assess other variables (potential risk factors), as well as LGP timing after DS to IOP levels at different time intervals. The regression model for the first group was: $\chi^2 = 26.788, (p = 0.002)$; TDM thickness, density, intrascleral channel and scan height, energy and the number of pulses were not significant. However the IOP showed significant dependence of long-term hypotensive efficacy of DS on LGP timing at 6 (p = 0.005), 24 (p = 0.0001) and 36 (p = 0.005) months respectively.

The regression model for the second group was: $\chi^2 = 26.037, p = 0.003$; TDM thickness, density, intrascleral channel and scan height, energy and the number of pulses were not significant. The IOP showed significant dependence of long-term hypotensive efficacy of DS on LGP timing at 12 months (p = 0.05), 24 (p = 0.006) and 36 (p = 0.05) months respectively. These findings support the belief that long-term hypotensive efficacy of DS depends on LGP timing.
Discussion

Deep sclerectomy has a proven safety profile in the early postoperative period compared to TE. [1,17,18] Different authors associate unsatisfactory long-term outcomes of DS with TDM thickening.[11,12,19,20] By UBM scans TDM looks like a “continuous” linear hyperechoic structure bordering the anterior chamber space and the cavity of intrascleral channel, and the change in TDM morphology (increased density and thickness) is associated with the intrascleral and scan height decrease, and in the delayed LGP group it is also associated with IOP elevation 3-4 months after the surgery. Based on our experience over the past several years, if TDM is thickened, obliteration of the scleral cavity, “loss” of the filtering bleb, IOP decompensation occur from 3 to 6 months after DS, if LGP was not performed. Consequently, the functional state of TDM determines the adequate AH outflow pathways formation (Fig 3 a,b). Nitin Anand and Rachel Pilling refer to a gradually increased resistance to outflow in TDM window, accompanied by gradual and progressive subconjunctival fibrosis.[21] Ike Ahmed et al associate existence and the size of scleral cavity with TDM filtering ability as a key success factor for DS.[22] Al Obiedan remarks that with an insufficient TDM filtering ability, IOP elevates.[23]

Most experts recognize the fact that the main determinant of AH outflow after DS is TDM, thus the main strategy for increasing the outflow is LGP, which creates a direct connection between the anterior chamber, the intrascleral and subconjunctival spaces. Recent studies show that the frequency of LGP following DS varies from 6-8 weeks to several years (from 4.7% to 63.0%).[21,22,24-29] Hara T1, Hara T [25] were the first to report a two-step procedure, DS followed by Nd: YAG laser removal of the remaining trabecular meshwork a few days after. Zsolt Varga and Tarek Shaarawy [1] speak about DS efficacy if LGP performed to reach the target level. LGP in 41% of cases immediately increase hypotensive success at 83% of eyes after primary DS.[24,26] Mean interval between DS and LGP is 9.9 months, mean decrease of IOP level is from 22.2±7.0 mm Hg to 12.6±3.8 mm Hg, the follow-up is about a year. Lachkar et al report about LGP in 47.3% of cases during the 54±17 months follow-up interval.[27] Similarly, in study of Detry-Morel and Detry, 63% of patients underwent LGP with mean IOP ≤ 15 mm Hg.[28] Tam et al report on 42% cases of IOP decrease after LGP (from 20.2 to 11.7 mm Hg) performed at 12.4±10 months interval.[12] IOP decreases by 20% of the initial value during 2 years in 50% of cases.[21] The functional state of the outflow pathways after DS depends on the filtering capacity of the TDM, so LGP is likely to be required in most cases to maintain the IOP level. According to recommendations of Shaarawy T et al, LGP is not a complication or disadvantage of DS.[2,11,29] The wide time range of LGP performance indicates that problems with the filtration capacity of TDM can occur at different time periods, consequently LGP can be performed both earlier or later after DS. [12,16,20] Data on
indications, timing, and frequency of LGP are controversial, and there are not enough convincing results of long-term hypotensive efficacy of DS in relation to the LGP timing.

D. Holmes et al, comparing the LGP timing - early (up to 3 months) and delayed (more than three months) in relation to the IOP criteria, found no statistically significant difference between the groups.[30] However, the authors confirmed that the procedure was safe regardless of its time performance and may be performed at early time intervals after DS. In the study at the target IOP level ≤ 15 mm Hg, complete success rate was 45.5% after 2 years and decreased to 32.5% after 5 years.

Our study is one of the first comparing delayed LGP and early LGP, affecting the target level of IOP after DS. LGP was an adjuvant procedure based on UBM data, indicating the dynamic of TDM thickening and its direct impact on intrascleral channel and scan height after DS. In the first group (delayed LGP) changes in UMB semiotics with IOP elevation accompanied my morphological changes such as TDM thickening, intrascleral channel and scan height lowering. In the second group (early LGP), although the IOP level remained in normal range, indications to LGP were the UBM data. This approach allowed to get a higher hypotensive efficacy in a long-term follow up (75.6% after 24 months, 48.9% after 60 months with a target IOP of 15 mm Hg) and demonstrated a higher safety profile of early LGP.

This study has demonstrated that early LGP excludes TDM influence on further formation of the intrascleral cavity and outflow pathways. LGP performed in group 2 does not have serious complications and the postoperative routine does not change. After LGP, TDM becomes a micro-fistula, and the procedure becomes a microfistulizing operation, including surgical and laser stages. TDM transformation into a micro-fistula does not change the basic principles of DS and does not compromise its high safety profile with no or minimum of intra- and early postoperative complications.[21,28] Over the entire follow-up period, visual acuity (log - MAR) decreased by 0.21±0.14 and was associated with cataract progression in 12% in the first group, 8% in the second that didn’t depend on the surgery. In one case of group 1, visual acuity decrease by 0.35 was associated with the development of a wet form of age-related macular degeneration.

LGP maintains aqueous outflow through TDM preventing scarring in the subscleral and subconjunctival level accompanied significantly better IOP outcomes. In group 1, delayed LGP was associated with a number of postoperative interventions and significantly lower rate of hypotensive success in a long-term follow up. In group 2, two-stage technique with early LGP demonstrated more pronounced “complete hypotensive success” in a long-term follow-up.
Despite LGP performed, further UBM morphology changes in intrascleral cavity and filtering bleb was recorded in both groups. In these cases bleb manipulations preventing outflow pathways scarring were performed.

This study has some limitation. As it has a retrospective features, it included only comparison groups and no control group that could be represented by a group of patients after DS without LGP during the follow-up. However, the study does not deny the fact that there are cases of DS that do not require LGP and yet have higher survival rates, probably due to high filtering capacity of TDM and the smooth course of the postoperative period. A small sample may also be considered a possible limitation of this study. Further prospective trials with a larger sample size, with the same operating techniques and medication support (MMC, 5-FU, drainages, etc.), as well as further study of the TDM ultrastructure and factors affecting its filtering ability, will determine the place and LGP timing, proving full hypotensive efficacy after DS and confirm the safety of early LGP in the increase of hypotensive efficacy after DS.

The difference in IOP between groups can be explained not only by focusing on IOP level but also UBM data and that could be a limitation of this study.

As a conclusion, early performed Nd:Yag laser goniopuncture plays a key role in outflow pathways formation after deep sclerectomy and has proven its efficacy and safety demonstrating more pronounced hypotensive success in a long-term follow-up period. No doubt the study of reasons for TDM thickening in non-penetrating surgery in various postoperative periods must be continued.

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The authors declare that there is no conflict of interest.
References


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Table 1. Patient demographics and baseline characteristics

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<th>Group 1</th>
<th>Group 2</th>
<th>p value</th>
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<tr>
<td><strong>No. patients</strong></td>
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<td>112</td>
<td></td>
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<tr>
<td><strong>Male</strong></td>
<td>42</td>
<td>36</td>
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<tr>
<td><strong>Female</strong></td>
<td>74</td>
<td>76</td>
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<tr>
<td>white</td>
<td>102</td>
<td>96</td>
<td>0.99</td>
</tr>
<tr>
<td>asian</td>
<td>14</td>
<td>16</td>
<td>0.98</td>
</tr>
<tr>
<td><strong>Age (y)</strong></td>
<td>56.62±12.23</td>
<td>54.71±14.24</td>
<td>0.84*</td>
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<td><strong>Preoperative glaucoma diagnosis</strong></td>
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<tr>
<td>Primary open angle</td>
<td>24</td>
<td>30</td>
<td>0.8</td>
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<tr>
<td>Pseudoexfoliation</td>
<td>86</td>
<td>78</td>
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<td>Pigmentary</td>
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<tr>
<td><strong>Concomitant ocular diseases</strong></td>
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<tr>
<td>Cataract</td>
<td>24</td>
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<tr>
<td>Age-related macular degeneration</td>
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<td><strong>Preceeding surgeries</strong></td>
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<tr>
<td><strong>Glaucoma severity</strong></td>
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<tr>
<td>mild</td>
<td>20</td>
<td>16</td>
<td>0.8</td>
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<tr>
<td>moderate</td>
<td>66</td>
<td>76</td>
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<tr>
<td>severe</td>
<td>30</td>
<td>20</td>
<td>0.7</td>
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<tr>
<td><strong>Intraoperative subconjunctival 5-fluorouracil (n)</strong></td>
<td>116</td>
<td>112</td>
<td></td>
</tr>
<tr>
<td><strong>Nd:YAG LGP (n)</strong></td>
<td>116</td>
<td>112</td>
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<tr>
<td><strong>Mean follow-up (mo)</strong></td>
<td>60</td>
<td>60</td>
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Group 1 (delayed LGP), Group 2 (early LGP)

IOP – intraocular pressure
Nd:YAG LGP – neodymium-doped:yttrium-aluminium-garnet laser goniopuncture

*Independent t-test
• Person χ²
Table 2. Characteristics, complications and interventions after Nd:YAG LGP

<table>
<thead>
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<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>p value</th>
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<tr>
<td><strong>Timing of Nd:YAG LGP (mo)</strong></td>
<td>3.46±1.9 (1.5 – 6.7)</td>
<td>1.12±0.08 (0.9 – 1.5)</td>
<td>0.0001*</td>
</tr>
<tr>
<td><strong>IOP level before Nd:YAG LGP (mm Hg)</strong></td>
<td>18.48±4.7 (11.2-22.9)</td>
<td>15.7±4.1 (9.1 – 18.5)</td>
<td>0.001*</td>
</tr>
<tr>
<td><strong>Pulse energy (mJ)</strong></td>
<td>3.85±0.9 (2.7 – 5.0)</td>
<td>1.95±0.6 (1.6 – 2.3)</td>
<td>0.0001*</td>
</tr>
<tr>
<td><strong>Pulse number (n)</strong></td>
<td>9.2±1.6 (8 – 12)</td>
<td>5.0±1.6 (3 – 7)</td>
<td>0.0001 ••</td>
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<tr>
<td><strong>Argon laser iridoplasty (n,%)</strong></td>
<td>24 (20.6%)</td>
<td>18 (16.1%)</td>
<td>0.7 •</td>
</tr>
</tbody>
</table>

**Complications after Nd:YAG LGP**
- Hypotension without choroidal effusion (n,%): 2(1.7%) vs 2(1.7%)
- Hypotension with choroidal effusion (n,%): 10 (8.6%) vs 4 (3.5%)
- Hyphema (n,%): 2(1.7%) vs 2(1.7%)
- Iris occlusion during LGP: -
- Iris occlusion after LGP: 2(1.7%) vs 2(1.7%)
- Bleb injury: 2(1.7%) vs -

**Subsequent interventions after NPDS and Nd:YAG LGP**
- **Subconjunctival 5-fluorouracil injection (n,%):** 56 (48.3%) vs 28 (25%) p = 0.02 •
- **Needle revision (from 2 to 6 procedures) (n,%):** 62(53.4%) vs 36(32.1%) p = 0.03 •
- **Postoperative laser suturelysis (n,%):** 18 (15.5%) vs 10(8.9%) p = 0.03 •

Group 1 (delayed LGP), Group 2 (early LGP)

IOP – intraocular pressure
Nd:YAG LGP – neodymium-doped:yttrium-aluminium-garnet laser goniopuncture

*Independent t-test
• Person χ²
•• Mann-Whitney
### Table 3. UBM - semiotics of Trabeculo-descemet's membrane, intrascleral canal and scan height

<table>
<thead>
<tr>
<th>Period</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; day</th>
<th>before Nd:YAG LGP</th>
<th>after Nd:YAG LGP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1</td>
<td>Group 2</td>
<td>Group 1</td>
</tr>
<tr>
<td>TDM height, mm</td>
<td>0.952±0.07 (0.89–1.35)</td>
<td>0.957±0.09 (0.91–1.41)</td>
<td>0.952±0.07 (0.89–1.35)</td>
</tr>
<tr>
<td>TDM thickness, mm</td>
<td>0.07±0.006 (0.05–0.09)</td>
<td>0.07±0.002 (0.05–0.09)</td>
<td>0.12±0.009 (0.09–0.13)</td>
</tr>
<tr>
<td>TDM density, %</td>
<td>40±5 (35 – 45)</td>
<td>40±5 (35 – 45)</td>
<td>50±6 (49 – 56)</td>
</tr>
<tr>
<td>ISC height, mm</td>
<td>0.55±0.05 (0.28–0.40)</td>
<td>0.56±0.01 (0.3 – 0.42)</td>
<td>0.39±0.19 (0.20–0.40)</td>
</tr>
<tr>
<td>Scan height, mm</td>
<td>1.62±0.25 (1.49 – 2.1)</td>
<td>1.61±0.31 (1.49 – 2.1)</td>
<td>1.49±0.35 (1.41 – 1.9)</td>
</tr>
</tbody>
</table>

UBM - Ultrasound Biomicroscopy  
TDM – Trabecular-Descemet’s membrane  
Nd:YAG LGP – neodymium-doped:yttrium-aluminium-garnet laser goniopuncture  
*Independent t-test  
** Mann–Whitney
Figure Legends

**Figure 1.** Mean IOP values after deep sclerectomy, before and after Nd:YAG laser goniopuncture during the follow-up

**Figure 2.** Kaplan-Meier survival estimates comparing complete hypotensive success after deep sclerectomy and Nd:YAG laser goniopuncture during the follow-up (for IOP ≤ 15 mm Hg and 20% decrease with no glaucoma medication).

**Figure 3.** Ultrasound biomicroscopy of TDM functional state determining the adequate aqueous pathways formation after deep sclerectomy (a – day 3 after deep sclerectomy; b – 2 years after deep sclerectomy followed by Nd:YAG laser goniopuncture).