

Selective laser trabeculoplasty after canaloplasty improves the efficacy of intraocular pressure reduction in eyes with open angle glaucoma

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Glaucoma is the second cause of blindness worldwide, and it has an increasing trend, where primary open angle type is the most common one. Surgical interventions are recommended for uncontrolled cases and patients with poor compliance to treatment. Canaloplasty is a highly recommended procedure, especially among patients at high risk of infection or bleeding. Advanced technology facilitates canaloplasty by using a microcatheter in the Schlemm's Canal to increase the drainage through the canal. Studies have been published demonstrating the long-term efficacy and safety of canaloplasty; however, a percentage of patients may not achieve the target pressure postoperatively. Consequently, in order to prevent disc damage, instead of adding medications or repeating surgery, selective laser trabeculoplasty (SLT) may be an additional option to achieve the target pressure. In the current study, we aimed at investigating the efficacy of adding SLT after canaloplasty to achieve a lower intraocular pressure (IOP) level.

In the current case series, we recruited and followed-up a number of patients with a confirmed diagnosis of primary open angle glaucoma (OAG), and who were eligible for glaucoma surgery at the Riyadh National Hospital, Kingdom of Saudi Arabia from February 2012 through December 2012. Indications for surgery were those having an elevated IOP (>21 mm Hg) with the maximum tolerated anti-glaucoma medication. We started our surgical intervention with the canaloplasty procedure, followed by SLT (180 degrees) when the postcanaloplasty IOP was not conveniently reduced to a safe threshold. All patients underwent a complete baseline ophthalmic examination which included: the ocular history; ophthalmic and systemic medication usage; best-corrected visual acuity (BCVA); IOP by unmasked Goldmann applanation tonometry; slit-lamp examination; assessment of central corneal thickness; vertical cup/disc ratio (CDR); gonioscopy; and fundus examination.

Ethical approval for the current study was sought through the research and ethics committee at the Riyadh

National Hospital, and the current study complies with the tenets of the Declaration of Helsinki for research involving humans. Informed written consent was signed by every patient a priori after a detailed explanation to the patient.

Canaloplasty surgery was carried out, and patients were followed-up for 3 months where all clinical indices were assessed. Additional SLT procedure was conducted to those who failed to achieve the target reduction of IOP. Patients were followed-up again for approximately 3 months for confirmation of success. Six eyes of 4 patients were consecutively recruited in the current study (2 bilateral and 2 unilateral). The mean \pm standard deviation (SD) age of subjects at presentation was 56.7 ± 6.3 (range: 50-65), and 2 patients were males and the other 2 were females. Co-morbidity with systemic diseases was recognized in 2 patients as they were both diabetic and hypertensive. Family history of glaucoma was negative among all recruited patients, however, consanguinity was detected in 2 of them. Only one patient was aware of having glaucoma at presentation. At presentation, the mean \pm SD IOP was 34.2 ± 2.6 mm Hg, vertical CDR was 0.61 ± 0.17 , logMAR visual acuity was 0.87 ± 0.12 , while the average number of anti-glaucoma medications used was 2.8 ± 0.41 . The mean \pm SD follow-up duration was 108 ± 5.6 days. As a result of administering anti-glaucoma medications, the IOP significantly decreased from 34.2 ± 2.6 mm Hg at presentation to 23.5 ± 3.9 mm Hg ($p=0.026$). After conducting canaloplasty surgery, the mean IOP decreased from a preoperative value of 23.5 ± 3.9 mm Hg to 10.5 ± 2.3 mm Hg in the first postoperative day assessment, where such a reduction was statistically significant ($p=0.015$). This postoperative reduction has slightly and significantly increased during the first week follow-up visit to 13.8 ± 3.1 mm Hg ($p=0.026$). Moreover, in the first month, it increased further to 14.7 ± 2.9 mm Hg, and at the second month follow-up visit it continued to rise to 14.8 ± 2.6 mm Hg, however, the increments were statistically insignificant ($p=0.059$ and $p=0.317$). In the pre-SLT intervention assessment, the mean IOP of 16.2 ± 2.3 mm Hg was significantly increased compared to the 2 months post-canaloplasty assessment, and such an increment was statistically significant ($p=0.038$). Furthermore, the mean IOP had significantly decreased from the pre-SLT intervention value of 16.2 ± 2.3 mm Hg to 13.8 ± 1.7 mm Hg postoperatively. This reduction due to SLT intervention was found to be statistically significant ($p=0.026$). Combining both interventions, the mean overall decrease in IOP from its baseline value of 23.5 ± 3.9

mm Hg to its final value of 13.8 ± 1.7 mm Hg was 9.7 mm Hg (41.3%), which was statistically significant ($p=0.027$).

The SLT provided a new choice for the reduction of intraocular pressure (IOP) in eyes with OAG. The SLT procedure was demonstrated to be equally as effective as topical medical therapy and argon laser trabeculoplasty (ALT) in lowering IOP. Nagar et al¹ represented the outcomes of SLT versus drug therapy for glaucoma patients in a prospective randomized clinical trial, however, there was no statistically significant difference between the groups within his series. Furthermore, SLT can be considered as a primary treatment option in patients who cannot tolerate, or are noncompliant to medications, meanwhile, it does not lower the probability of success, if decision of surgery was taken down the road. However, SLT disadvantages may include mild and transient inflammations, ocular pain, and a small risk of moderate IOP elevations after the procedure.²

Recently, many studies have reported the efficacy of SLT in the reduction of IOP (Table 1). These results support SLT as a safe and effective option for initial therapy among patients with OAG. There is an increasing evidence that canaloplasty obviates the need for a subconjunctival filtering bleb. The major role of such bleb is to shunt aqueous to an alternative non-physiological route. Meanwhile, there is a convenient rationale to believe that the addition of circumferential viscodilatation of Schlemm's canal and the trabecular meshwork tensioning in canaloplasty may provide an additional IOP-lowering effect compared to the creation of a scleral lake and a Descemet's window alone, as is often achieved with deep sclerectomy or viscocanalostomy.³ Canaloplasty solves the problem of a collapsed Schlemm's canal by circumferentially

catheterizing, viscodilating, and suture tensioning the entire length of Schlemm's canal with the use of a flexible microcatheter, so that the outflow takes its natural pathway, but the resistance of trabecular meshwork, especially juxtacanalicular apparatus part, to the outflow is still remaining. Therefore, we assume that application of SLT to the stretched Schlemm's canal may enhance the action of SLT, and reduce the IOP of our patients.

As regard to complications, the incidence of microhyphema in our study was 4 of 6 eyes; nevertheless, none of the operated eyes in this study have shown hypotony or flat/shallow anterior chambers compared to the classic trabeculectomy. Post-trabeculectomy, the incidence of hyphema is reported in the range of 4-43%, hypotony is reported in the range of 10-42%, and flat/shallow anterior chambers are reported with an incidence of 13-43%.^{4,5}

The limitations in our study are the relatively small sample size in addition to the relatively short follow-up duration. However, we consider our study as a pilot study. A full study with a more appropriate sample size and convenient follow-up duration is required. Conduct of SLT intervention after canaloplasty in patients with OAG and uncontrolled IOP is a highly efficient and safe procedure with minimal, or no operative or postoperative complications.

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Table 1 - Demonstration of some selected selective laser trabeculoplasty studies.

Author	Year of study	Number of eyes	Follow-up	Mean IOP reduction (mm Hg)	% IOP reduction
Gracner ⁶	2001	50 OAG	6 months	5.1	22.5
Melamed et al ⁷	2003	45 OAG	6 -18 months	7.7	30
Lai et al ⁸	2004	58 OAG/OHT	5 years	8.7	32
Cvenkel ⁹	2004	44 OAG	1 year	7.1	27.6
McIlraith et al ¹⁰	2006	74 OAG/OHT	1 year	8.3	31
Weinand & Althen ¹¹	2006	52 OAG	1 year 4 years	6 6.3	24.3 29.3

SLT - selective laser trabeculoplasty, IOP - intraocular pressure, OAG - open angle glaucoma, OHT - ocular hypertension

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