

## ORIGINAL ARTICLE

## EFFICACY OF DIODE LASER IN THE MANAGEMENT OF GLAUCOMA FOLLOWING INTRAVITREAL SILICONE OIL INJECTION IN COMPLICATED RETINAL DETACHMENT

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**Background:** Intravitreal silicone oil injection has been used to manage complicated retinal detachment. This study aims to analyse the efficacy of diode laser (TSCPC) in the management of secondary glaucoma following intravitreal silicone oil injection in complex retinal detachment surgery. **Methods:** The medical records of 58 eyes of 58 patients retrospectively were reviewed. Patients who underwent TSCPC for the management of secondary glaucoma following intravitreal silicone oil injection in complex retinal detachment were included. Procedure performed under local anaesthesia. The laser power was set at 1500–2200 mW for 2 sec. At each follow-up visit, patients went under charting of their IOP measurements with anterior segment and fundus examination. Post procedural follow up visits were carried out as; at 1 week, 1<sup>st</sup>, 3<sup>rd</sup> and 6<sup>th</sup> months. The efficacy was measured as reduction in IOP up to  $\leq 20$  mmHg without further needs for medications at 6 months. **Results:** The IOP was reduced up to  $19.26 \pm 10.15$  mmHg. Comparisons of IOP at each interval with pre-treatment showed significant difference with  $p < 0.0001$ . The efficacy of procedure was achieved in 77.6% patients. Age, gender and pre-operative IOP showed significant association with  $p < 0.05$ . **Conclusion:** Diode laser TSCPC was effective and safe in reducing IOP. The IOP decreases gradually over six month follow up. The procedure is simple and cost-effective yet reasonably afforded by patients in low resources population. In spite of the retained intravitreal silicon oil patients with failed medical treatment for uncontrolled IOP can be treated with TSCPS.

**Keywords:** Intraocular pressure; Trans-scleral cyclophotocoagulation; Diode laser; Glaucoma.

**Citation:** Ahmed N, Mahar PS, Rehman A, Soomro AQ, Ateeq A, Bhutto IA, Younus M. Efficacy of diode laser in the management of glaucoma following intravitreal silicone oil injection in complicated retinal detachment. J Ayub Med Coll Abbottabad 2022;34(1):31–5.

## INTRODUCTION

Intravitreal Silicone oil (SO) injection has been used for the management of retinal detachments that is complicated by proliferative vitreoretinopathy.<sup>1</sup> However, the use of silicone oil can result in the secondary glaucoma with increase in the intraocular pressure (IOP), causing damage to the optic nerve in a patient who already has compromised vision due to retinal problem. The literature is evident that around 5.9–48% cases have been reported as silicone induced glaucoma.<sup>2,3</sup> Using intravitreal SO injection has clearly shown promising outcomes in cases where a complicated retinal detachment occurs. Nevertheless, secondary glaucoma with raised IOP can be problematic. Unfortunately, most of these patients are resistant to medical treatment to have their IOP under control. Removal of SO is the choice of treatment in these patients. Though, due to complications like the retinal re-detachment or hypotony, an ophthalmologist might be hesitant to adopt this course of treatment<sup>4</sup> and there is conflict of the advantage of silicone oil removal secondary to increase in IOP. Several studies have revealed

stabilization of IOP after SO removal<sup>5</sup> whereas some researchers have recommended that removal of SO alone may not be sufficient to eliminate the risk of glaucoma<sup>6</sup>.

Traditionally raised IOP has been treated with medical therapy and cases not amenable to control require surgery in the form of trabeculectomy and use of setones.<sup>7</sup> The topical therapy often fails to reduce IOP in silicon filled eyes. The alternative has been developed in form of diode based trans-scleral cyclophotocoagulation (TSCPC). Recently, this modality has been widely utilized for control of high IOP in such cases. The success rate of TSCPC in order to reduce IOP is between range of 37–82% in various series.<sup>8–10</sup> Nevertheless, the success of the management is defined as achieving IOP of less than or equal to 20 mm Hg depending upon different types of treatment algorithms in various types of glaucoma. Trans-scleral cyclophotocoagulation with diode laser has been a well-established modality in treating secondary glaucoma with raised IOP in silicon-filled eyes, which had failed to respond to medical and surgical treatment. It is significant especially in those eyes with minimal visual potential.<sup>11,12</sup>

The purpose of this study is to assess the efficacy of trans-scleral cyclodiode therapy in the reduction of intraocular pressure. Majority of the patients are managed effectively with anti-glaucoma medicines. Eyes that do not respond to medical treatment can be successfully treated with surgical interventions. This research was carried out to ascertain the outcome of increased IOP after pars plana vitrectomy and silicone oil injection in complicated retinal detachment. The purpose of this analysis was to examine IOP changes in silicone oil treated eyes for the management of complicated RD. Most of the studies have focused on glaucoma treatment in silicone-filled eyes. Therefore, there is paucity of recent local findings to our best information available. Hence, our focus in this study is to evaluate the outcome assessed in terms of intraocular pressure with treatment deemed to be successful if the IOP is  $\leq 20$  mm Hg without any additional medical treatment.

## MATERIAL AND METHODS

This retrospective observational study was conducted in the department of Ophthalmology, Al-Ibrahim Eye Hospital/ Isra Postgraduate Institute of Ophthalmology, Karachi, Pakistan from January 2019 to February 2020. The research protocol was reviewed and approved by institutional ethics committee. The sample size was calculated using Open Epi calculator taking expected percentage of efficacy of diode laser TSCPC in the management of raised intraocular pressure as 81.8%<sup>10</sup>, in patients presented with silicone oil filled eyes, with 95% confidence level, 10% desired precision. The calculated sample size came out as 58.

All the patients between ages between 17–81 years of age who developed raised IOP  $\geq 30$  mm Hg following intravitreal SO injection in complex RD surgery were included in the study. Patients with corneal decomposition, cataract, and uveitis, having any complications of surgery and previous history of TSCPC were excluded from the study. All patients underwent TSCPC procedure for glaucoma after taking consent from all the patients. Each patient had received 5–10 cc of 5000 Centi Stokes (CST) silicone oil (Micromed srl – Italy) during surgery. All RD surgeries were performed about six months earlier and still retained SO. The patient's age, gender, side of the eye and vitreo retinopathy diagnosis were recorded in the preform. All patients went through detailed ocular examination which included medical record of their Best Corrected Visual Acuity (BCVA) with anterior segment slit lamp bio-microscopy and fundus examination using + 90 Dioptervolk lens and indirect ophthalmoscope. The IOP was measured at

baseline and post-treatment by using Goldmann Applanation Tonometer (GAT) by the same surgeon.

Diode laser TSCPC (Oculight – Iris Medical, USA) was performed under local anaesthesia with peribulbar lignocaine 2% given in 3 ml amount. The surface anaesthesia was achieved with proparacaine drops (Alcaine – Alcon, Belgium). The laser power was set at 1500–2200 mW at fixed spot size and laser was applied over the two quadrants of limbus (180 degrees) with a maximum of 16 applications for 2 second of duration. Using a 600 mm (micrometer) laser delivery probe (G-probe), the probe was placed 1.5 mm posterior to the limbus. The 3 and 9 O'clock meridians were spared because of ciliary nerves and vessels. Following TSCPC, all the study subjects were managed with fluromethalone 0.1% eye drops 4 times/per day, atropine 1.0% eye drops twice a day along with analgesics (orally). Pre-laser glaucoma treatment was continued in post-laser phase and gradually tapered off according to the level of IOP. The laser procedure was performed by the same surgeon on all patients. The efficacy of the treatment was measured as reduction of IOP to  $\leq 20$  mmHg without addition of any glaucoma drops. At each follow-up visit, patients went under charting of their BCVA, IOP measurements with anterior segment and fundus examination. The Post procedural follow up visits were carried out as; at 1 week, 1<sup>st</sup>, 3<sup>rd</sup> and 6<sup>th</sup> months postoperatively. The topical steroid drops and cycloplegic were discontinued at 4 weeks after the laser treatment.

SPSS version 25 for Windows was used to analyse the data after completion of data collection. Mean and standard deviation was used for quantitative variables. Frequency and percentage were measured for qualitative variables. Paired t-test was applied to compare pre and post treatment IOP and chi-square test was applied to assess the association of efficacy with other study variables taking *p*-value of less than or equal 0.05 was considered as significant.

## RESULTS

A total of fifty-eight eyes with raised IOP  $\geq 30$  mm Hg following intravitreal silicon oil injection not controlled with topical glaucoma therapy were included in the study. The age range of patients was 17–81 years with mean age of 46.94 $\pm$ 12.9 years. Out of 58 patients 30 (51.72%) were male and 28 (48.28%) were female. Patient's characteristics and diagnosis are shown in table-1.

The mean $\pm$ SD of IOP before treatment was 37.22 $\pm$ 9.15 mmHg. The mean $\pm$ SD of IOP at one-week post laser was 21.89 $\pm$ 8.87 mmHg, at 1 month was 19.04 $\pm$ 6.21 mmHg, at 3 months was 15.98 $\pm$ 4.11 mmHg and after 6 months of treatment was

17.96±6.24 mmHg. (Figure-1) Overall, there was a decrease of 19.26±10.15 mmHg in IOP compared to pre laser level. Comparison of repetitive measures at each interval also showed significant difference (*p*-value: 0.0001). The pair wise comparison showed significant difference in IOP at each interval as compared to pre-treatment level (*p*-value <0.0001). (Table-2)

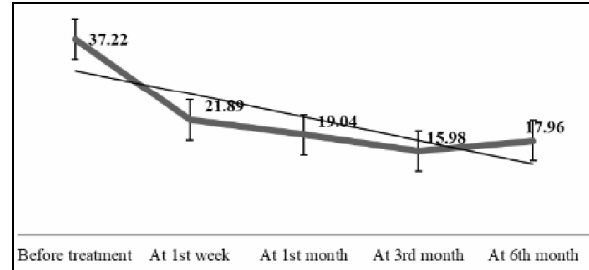


Figure-1: Pre and post treatment mean intraocular pressure

We have defined efficacy as a final IOP equal to or lower than 20 mm Hg without visual loss or hypotony and this was achieved in 45 (77.6%) eyes while remaining patients' needs further treatment. (Figure-2)

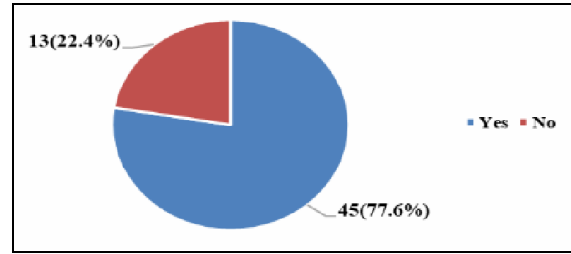


Figure-2: Efficacy and diode laser TSCPC in the management of raised IOP

In table-3, we have described association of efficacy in control of IOP with study variables such as age, gender, VR diagnosis, side of eyes and pre-treatment IOP. The age, gender, and pre-operative IOP of the patient has shown significant association with control of IOP (*p*<0.05). Patients of age 50 or less have higher efficacy rate, similarly female gender has also shown better results while other variable's association remains insignificant (*p*>0.05).

Table-1: Patient's characteristics

Patient's characteristics	Frequency	Percent
<b>Age (in years)</b>		
≤50 years	38	65.52
>50 years	20	34.48
<b>Gender</b>		
Female	28	48.28
Male	30	51.72
<b>Side of eyes</b>		
Left	31	53.45
Right	27	46.55
<b>Vitreo-retina Diagnosis</b>		
Proliferative Diabetic Retinopathy	2	3.45
Proliferative Diabetic Retinopathy + Tractional Retinal Detachment	22	37.93
Rhegmatogenous Retinal Detachment	25	43.10
Tractional Retinal Detachment	9	15.52

Table-2: Comparison of Pre and Post treatment IOP

Intraocular pressure (IOP)	Mean	Std. Deviation	<i>p</i> -values	Remarks	
Pair 1	Before treatment	37.22	9.14	<0.0001*	Significant
	At 1st week	21.89	8.86		
Pair 2	Before treatment	37.22	9.14	<0.0001*	Significant
	At 1st month	19.04	6.20		
Pair 3	Before treatment	37.22	9.14	<0.0001*	Significant
	At 3rd month	15.98	4.11		
Pair 4	Before treatment	37.22	9.14	<0.0001*	Significant
	At 6th month	17.96	6.24		

Table-3: Association of efficacy with patient's characteristics

Study variables	Efficacy		<i>p</i> -values	Remarks	
	Yes	No			
Age Group	≤50 years	33 (86.8%)	5 (13.2%)	0.020	Significant
	>50 years	12 (60%)	8 (40%)		
Gender	Female	25 (89.3%)	3 (10.7%)	0.039	Significant
	Male	20 (66.7%)	10 (33.3%)		
Vitreo Retinopathy Diagnosis	PDR	2 (100.0%)	0 (0%)	0.811	Insignificant
	PDR+TRD	16 (72.7%)	6 (27.3%)		
	RRD	20 (80%)	5 (20%)		
	TRD	7 (77.8%)	2 (22.2%)		
Sides	Left	23 (74.2%)	8 (25.8%)	0.507	Insignificant
	Right	22 (81.5%)	5 (18.5%)		
Pre-treatment Intra-ocular pressure (IOP)	≤40	30 (88.2%)	4 (11.8%)	0.021	Significant
	>40	15 (62.5%)	9 (37.5%)		

## DISCUSSION

Trans-scleral cyclophotocoagulation diode laser is an established therapeutic approach to refractory glaucoma involving photocoagulation of the pars plicata ciliary body with a decrease in aqueous secretion leading to reduction of IOP. The use of intravitreal SO injection has shown promising results in cases where complicated RD has occurred. Late complications can prevent a satisfactory long-term outcome. Among them elevated IOP is one of the most common complications.

The silicon oil (SO) is a vitreous substitute used as an internal tamponade in complicated retinal detachment surgery. It is remained stable and biocompatible and does not go through any chemical alteration inside the eye. However, it can cause secondary glaucoma with raised IOP due to pupillary block and its migration in the anterior chamber angle impairing the aqueous flow.<sup>12</sup> Even after removal of SO, glaucoma can develop due to silicon bubbles infiltrating the trabecular meshwork and formation of peripheral anterior synechiae (PAS) due to chronic inflammation.<sup>13</sup> Most Vitreo-retinal surgeons prefer to remove SO between 3–6 months after surgery as once SO is left for longer period in the eye, it can cause emulsification resulting in damage to the structures in the anterior segment of the eyes with development of glaucoma, cataract and keratopathy.<sup>14</sup> The raised IOP unfortunately does not respond well to anti-glaucoma drops and even trabeculectomy and various Setons fail due to their blockage by silicon particles. The use of diode laser to control secondary glaucoma with raised IOP was first reported by Leaver and co-authors in 1979.<sup>15</sup> Since then there are multiple reports of usefulness of diode laser controlling IOP in silicon oil induced glaucoma.<sup>16,17</sup>

The present study showed that TSCPC procedure was effective in controlling raised IOP in 77.5% of cases when topical glaucoma therapy failed to bring IOP down. We employed diode laser involving 180 degrees of the angle and did not find any unwanted complications at the end of our follow-up. In agreement of current study, Henderer *et al*<sup>18</sup> also stated that approximately similar rate of success 79% patients for a year who were treated with SSO for complicated RD and also revealed that raised postoperative IOP were most likely associated with glaucoma, diabetes mellitus. Prophylactic treatment ought to be considered in high-risk eyes. In our study older age, male gender and high pre-operative IOP found to have significant factors of poor treatment effect ( $p$ -value<0.0001). Singh *et al*. reported that the decrease in IOP was 58.5% at 9 months follow-up.<sup>19</sup> Studying age, sex, preoperative IOP, type of RD

needing vitrectomy, and lens status as risk factors for hypotony showed no statistical significance.<sup>20</sup>

Aygün *et al*<sup>21</sup> reported that restricting the degree of laser treatment to 180 degrees is related with a lesser aggressive impact and is quite safe with around 67% of eyes in his study attaining optimum IOP after first session of treatment. Siva gnanavel *et al*<sup>22</sup> treated 18 eyes with TSCPC and found that 56% of his patients had treatment failure. One of the reasons for treatment failure was attributed to the long duration of SO present in patient's eyes at 33.7 months and also there was pre-existing glaucoma present in 7 of his treated patients. Majority of our patients had successful outcome in reduction of their IOP and can be due to SO not present for more than 6–9 months duration.

Ghazi-Nouri and co-authors<sup>23</sup> published results of 38 patients undergoing TSCPC with follow-up of 13–113 months. The mean baseline IOP in their patients was 31.4 mm Hg reduced up to 18.6 mm Hg $\pm$ 8.6 at 12<sup>th</sup> month and to 13.9 mm Hg $\pm$ 8.4 at their last follow-up visit. All patients had successful outcome in reduction of IOP however 11% at 1 year and 13% at the final visit developed hypotony described as IOP of <5 mm Hg.

Aujla and co-researchers<sup>24</sup> have reported hypotony and sympathetic ophthalmitis following TSCPC. Out of their 70 patients with refractive glaucoma, 7 eyes (patients) developed hypotony and this was linked to the total energy of diode laser delivered during the treatment at 192.5 $\pm$ 73.2 Joules. In comparison, we did not see any patient developing hypotony (IOP of <5 mm Hg) in our series as total energy applied during treatment was for less. Hypotony has also been reported in other reports where 360 degrees of laser treatment was performed specially in cases with nonvascular glaucoma.<sup>25</sup>

The huge variation in the outcome of TSCPC in controlling IOP mirrors the absence of standard protocol including type of glaucoma, power used and quadrants of eye treated with diode laser. The limitation of our study is that it is single centred, descriptive in nature and with only six months follow-up.

## CONCLUSION

In conclusion; the results showed that diode laser TSCPS was effective and safe in reducing intraocular pressure where other modalities to reduce IOP fail. The intraocular pressure reduces gradually over six month follow up. The reduce IOP provides positive effect on patient's quality of life and dependency on number of medications is decreased. The procedure is simple and cost-effective yet reasonably afforded by patients especially in a developing and low resources country like Pakistan. The procedure is highly in

effective in surgical patients at high risk or patients having drug overdose. Moreover, the procedure bears fewer complications as compare to other procedures and can be successfully used to treat secondary glaucoma.

### AUTHORS' CONTRIBUTION

NA: Conceptualization, data collection, data analysis, manuscript writing. PSM, AUR, AOS: Data collection, data analysis, manuscript writing. AA, IAB: Data collection, data analysis, manuscript writing. MY: Data collection, data analysis, manuscript writing

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Submitted: January 15, 2021

Revised: February 3, 2021

Accepted: June 6, 2021

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