Nd: Yag laser hyaloidotomy in the treatment of premacular subhyaloid haemorrage

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ABSTRACT

Purpose: To evaluate the efficacy and safety of Nd:YAG laser hyaloidotomy in the treatment of premacular subhyaloid haemorrhage (SHH)

Material and Methods: The study analyzed the medical records of 37 patients who underwent Nd:YAG hyaloidotomy for premacular SHH between 2014 and 2022. Patients were evaluated based on age, gender, etiology, symptom duration, visual acuity, laser energy, number of shots, complications, and need for additional procedures. The main success criteria were drainage and absorption of SHH, increased visual acuity, need for additional procedures, and post-procedural complications.

Results: A study of 37 patients with 39 eyes, with a mean age of 52.03 ± 20.51 years and symptom duration of 10.51 ± 7.43 days, found common etiologies such as proliferative diabetic retinopathy, retinal vein occlusion, retinopathy of valsalva, leukemia, retinal macroaneurysm, hypertensive crisis, choroidal neovascular membrane, and Terson syndrome. The mean laser energy performed was 7.38 ± 2.08 mJ, and the mean number of shots was 4.28 ± 1.87. Nd:YAG laser hyaloidotomy was successful in 87.17% of cases but failed in 2 patients with proliferative diabetic retinopathy, one patient with Terson syndrome, and one patient with leukemia. Visual acuity improved significantly in the 6th month.

Conclusion: Nd:YAG laser hyaloidotomy is a cheap, effective, safe, and noninvasive treatment method for the treatment of premacular SHH. It prevents the need for invasive vitreoretinal surgery and its complications. Visual prognosis depends on the etiology of SHH and associated macular changes.

Keywords: Subhyaloid, Haemorrhage, YAG, Laser, Hyaloidotomy, Surgery.

INTRODUCTION

Subhyaloid haemorrhages (SHH) are bleeding between the internal limitant membrane (ILM) and the hyaloid face. When located in the macular area, they can cause severe.[1,2] Although premacular or preretinal hemorrhage, subhyaloidal hemorrhage, and sub-ILM hemorrhages are often synonymously, SHH is only anatomically correct when the hemorrhage is anterior to the ILM.[3]

Proliferative diabetic retinopathy (PDR), retinal vein occlusion (RVO), retinal macroaneurysm, age-related macular degeneration (AMD), retinal arteriovenous malformations, hematologic diseases (aplastic anemia, leukemia etc.), physical effort (Valsalva retinopathy), Terson syndrome, and Purtscher retinopathy are some of the causes of SHH.

Although SHHs resolve spontaneously in most cases, this process can take several weeks or months, depending on the total amount of haemorrhage present. This usually affects the patient very negatively when it occurs bilateral or in the fellow eye of monocular patients. There may also be persistent visual loss due to pigmentary macular changes or epiretinal membrane (ERM) formation due to toxic damage after prolonged exposure to hemoglobin and iron.[4]

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Received: 29.02.2024
Accepted: 02.10.2024

J Ret-Vit 2024; 33: 266-272

DOI:10.37845/ret.vit.2024.33.43

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Treatment of SHH includes observation, Nd:YAG laser hyaloidotomy[5], pneumatic displacement of haemorrhage with intravitreal gas injection[6] and tissue plasminogen activator[7], and pars plana vitrectomy.[8]

Nd-YAG laser is a noninvasive method that can improve vision within days or even minutes by drainage of haemorrhage from the posterior hyaloid membrane into the vitreous. In our study, we analyzed patients with premacular SHH who were treated with Nd-YAG laser therapy and patients who underwent pars plana vitrectomy (PPV) after failed drainage that happens latter YAG laser hyaloidotomy.

MATERIALS AND METHODS

The medical records of the patients who were followed and treated with the diagnosis of premacular SHH due to various etiologies in the Ophthalmology Clinic of Sakarya Training and Research Hospital between 2014 and 2022 were retrospectively analyzed. 39 eyes of 37 patients were included in the study. Our study was approved by the Sakarya University Non-Interventional Clinical Research Ethics Committee (dated 26.09.2022 and numbered 288) and was conducted by the Helsinki principles. It was confirmed from the files that informed consent was obtained from the patients included in the study.

Age, gender, systemic disease status, etiologic factors, best corrected visual acuity (BCVA) at presentation and after treatment, intraocular pressure (IOP), biomicroscopic and fundus examination findings, YAG laser energy (mj) applied, number of shots, need for surgery, operative notes in surgical cases, and follow-up period were analyzed from patient records.

YAG Laser Hyaloidotomy Technique

In the retrospectively reviewed files, it was noted that Q switched Nd:YAG laser (Ellex Super Q, Ellex, USA) was applied near the lower edge of the SHH using a Trans Equator lens (Volk), avoiding the retinal vessels and fovea and protecting the underlying retina, targeting the posterior hyaloid in SHH; laser applications were started with 5 mj and gradually increased by 1 mj until a perforation appeared on the surface and blood drainage into the vitreous cavity became evident. The 1st week, 4th week, 3rd month, and 6th month visits of the drained patients were analyzed. Treatment efficacy criteria were defined as drainage and absorption of SHH into the vitreous cavity and improvement in visual acuity. Figure 1 shows before and after photos of successful YAG laser hyaloidotomy of SHH after valsalva.

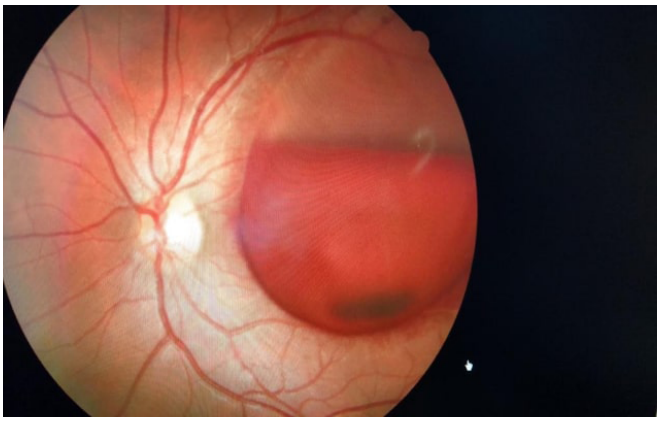

Figure 1: *Image of subhyaloid hemorrage due to Valsalva before YAG hyaloidotomy.*

It was noted that 23 gauge transconjunctival sutureless Pars Plana Vitrectomy(PPV) was performed under subtenon anesthesia in patients who failed YAG laser hyaloidotomy. The same surgeon performed all operations. There were no complications during surgery.

Statistical Analysis

The study used IBM SPSS 20.0 for statistical analysis, analyzing compliance with normal distribution using the Kolmogorov-Smirnov test. Normally distributed numerical variables were expressed as mean±standard deviation, while categorical variables were expressed as frequency. The difference between the dependent groups was determined using the dependent groups t-test. $p<0.05$ was considered statistically significant.

RESULTS

Nineteen (51.35%) of the patients were male and eighteen (48.65%) were female. The mean age of the patients ranging from 9 to 82 years was 52.03±20.51 years.

SHH was present in the right eye in 20 patients, in the left eye in 15 patients, and bilaterally in 2. Thirty-three patients

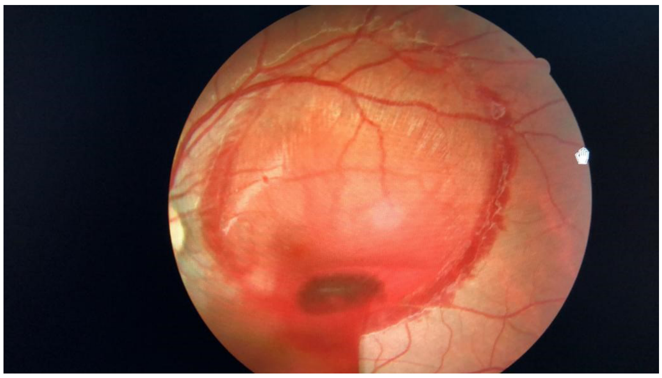

Figure 2: *Image showing subhyaloid hemorrage due to valsalva draining after successful YAG hyaloidotomy.*

with SHH were successfully treated with Nd-YAG laser hyaloidotomy. PPV was performed in 4 patients who failed Nd-YAG laser hyaloidotomy.

The mean BCVA before treatment with Nd-YAG laser was 2.89± 0.49 logMAR. Pre-laser visual acuity ranged between hand motion and counting fingers at 2 meters. Thirty eyes were phakic (76.93%), and nine eyes were pseudophakic (23.07%). The mean IOP values of the patients were 16±5 mmHg. The mean follow-up period before treatment was 10.51±7.43 days.

The mean number of laser shots was 4.28±1.87 (range 1-8). The mean energy required to perform posterior hyaloidotomy was 7.38±2.08 mj (min.5-max.12). After one week, visual acuity ranged between 1/20 and 20/20, at four weeks follow-up visual acuity ranged between 2/20 and 20/20, and at 3 and 6 months follow-up visual acuity ranged between 2/20 and 20/20.

The increase in BCVA was determined as the main functional success criteria. Resorption and resolution of haemorrhage were also evaluated as anatomical success. The mean BCVA before treatment was 2.86±0.52 logMAR in eyes with successful drainage with Nd-YAG laser. The mean BCVA at the 1st week after treatment was 0.32±0.35 logMAR, while the mean BCVA at the 1st, 3rd, and 6th month visits was 0.23±0.27 logMAR. Table 1 shows the values of BCVA before and after laser treatment. When the mean BCVA before treatment was compared with the mean BCVA at the 1st, 3rd, and 6th-month visits after treatment, the increase in BCVA was found to be statistically significant ($p<0.001$).

No complications were observed after Nd-YAG laser application, such as increased intraocular pressure, retinal and choroidal haemorrhage, macular hole, or retinal tear formation.

Etiologic factors in patients treated with Nd-YAG laser for SHH;

1. Proliferative diabetic retinopathy (13 eyes 33.3%)
2. Retinal vein occlusion (6 eyes 15.4%)
3. Hematologic diseases (leukemia, etc.) (5 eyes 12.8%)
4. Physical effort (Valsalva retinopathy) (5 eyes 12.8%)
5. Terson syndrome (4 eyes 10.3%)
6. Retinal macroaneurysm (2 eyes 5.1%)
7. Age-related macular degeneration (2 eyes 5.1%)
8. Hypertensive crisis (2 eyes 5.1%)

Nd-YAG laser was performed on average 10.51±7.43 days after symptom onset. It was determined that the treatment dose, starting at a minimum of 5 mj, was increased to 12 mj. The mean number of shots administered to patients with successful treatment of SHH with laser was 3.76±1.37. PPV was applied to 4 patients who could not achieve adequate drainage during follow-up. These patients received a mean of 11.6±0.54 mj and 7.8±0.44 shots. The mean preoperative BCVA of the patients who underwent PPV was 3.1 logMAR.

When the patients who underwent PPV were analyzed according to their etiologies;

PDR (2 eyes), Terson Syndrome (2 eyes), Leukemia (1 eye).

Postoperative Results

Postoperative 1st-week visual acuity was not statistically evaluated because of gas or silicone tamponade. The mean BCVA at postoperative 6th month was 0.31±0.44 logMAR. When the preoperative mean BCVA was compared with the postoperative mean BCVA at the 1st month, 3rd month, and 6th-month visits, the increase in BCVA was statistically significant ($p<0.001$). Preoperative and postoperative 1st month, 3rd month, and 6th-month BCVA min-max, median, mean, and p values are shown in Table 2.

Table 1: *BCVA values before and 1 week, 1, 3 and 6 months after laser*

BCVA logMAR	Min-Max	Median	Mean±SD	p
Preop	1.51-3.1	3.1	2.86±0.52	
1.week	0-1.3	0.22	0.32±0.35	<0.001
1.month	0-1	0.15	0.23±0.27	<0.001
3.month	0-1	0.15	0.23±0.27	<0.001
6.month	0-1	0.15	0.23±0.27	<0.001

BCVA: Best corrected visual acuity

Table 2: *Preoperative and postoperative 1st month, 3rd month and 6th month BCVA*				
BCVA logMAR	Min-Max	Median	Mean±SD	p
Preop	3.1-3.1	3.1	3.1±0	
1.month	0-1	0.05	0.31±0.44	<0.001
3.month	0-1	0.05	0.31±0.44	<0.001
6.month	0-1	0.05	0.31±0.44	<0.001
BCVA: Best corrected visual acuity				

As postoperative complications, IOP elevation (>22 mmHg) was detected in one eye on day 1, and antiglaucomatous treatment was started. IOP elevation was not detected in any patient in the subsequent follow-up.

Table 3 shows the age, symptom duration, diagnosis, number of shots, and max. energy power of all cases.

CONCLUSION

In our study, we performed Nd-YAG laser hyaloidotomy in 39 eyes of 37 patients for SHH. In 34 eyes, we obtained successful results with YAG hyaloidotomy. In 5 eyes, PPV was performed because SHH did not drain into the vitreous. Bilateral SHH was present in 2 patients with Terson syndrome. One of these patients had successful bilateral drainage with YAG hyaloidotomy. The other patient underwent PPV because the YAG hyaloidotomy failed. In 2 patients with SHH due to hypertensive crisis and one patient with SHH due to RVO, successful drainage was achieved after a single shot with 5mj. Our study is valuable because it has a large case series of 39 eyes showing the efficacy of Nd:YAG laser hyaloidotomy in treating SHH.

Nd:YAG laser-assisted drainage of premacular subhyaloid haemorrhage and sub-internal limiting membrane (sub-ILM) haemorrhage was described in the 1980s. Several studies have shown that this procedure is successful in treatment.[9-11]

In the literature, energy levels ranging from 2.5 to 50 mJ are mentioned about the energy level of Nd-YAG laser applied for SHH treatment. Gabel et al.[12] reported that 50 mJ energy was applied without retinal burn. It is best to start the treatment using the least energy and then gradually increase the energy level until a sufficient aperture is seen. Khadka et al.[11] reported that it is safe and effective to start hyaloidotomy with 5mj and increase the energy level by 1mj at each step up to 12mj. Kirwan et al.[13] reported that laser energy should not exceed 10.5 mJ due to the higher risk of complications in relation to macular hole, retinal rupture, and retinal detachment. In our study, YAG laser hyaloidotomy was started with 5 mj energy and increased to a maximum of 12 mj when required.

Timing is crucial for successful drainage of haemorrhage with hyaloidotomy. It is recommended to wait a maximum of 3 weeks for the haemorrhage to drain into the vitreous without organizing.[14] There are cases of 35 days and clotted haemorrhage that could not drain into the vitreous even if posterior hyaloidotomy was performed. However, it has been reported that full visual acuity was achieved in some haemorrhages waiting three months.[15]

In our study, the mean duration from symptom onset until hyaloidotomy was performed was 10.51±7.43 days. Successful drainage with hyaloidotomy was achieved a maximum of 32 days after symptom onset. We did not find any study showing the relationship between symptom onset time and drainage success.

A slowly resolving SHH can cause permanent vision loss due to pigmentary macular changes or enlargement of the epiretinal membrane, and can also prolong the contact of the retina with blood, hemoglobin and iron, possibly causing toxic damage to the retina and irreversibly reducing visual function.[3,11] Some studies have shown that premacular haemorrhage may coagulate, or rehaemorrhage may occur after successful drainage.[14,16,17] In our study, no rehaemorrhage was observed.

When the patients who were treated with PPV were analyzed, no successful drainage was observed despite a mean energy of 11.6±0.54 mj and 7.8±0.44 shots with YAG laser. The etiologic factors in these patients were PDR (n=2), Terson syndrome (n=2), and leukemia (n=1) in order of frequency.

In cases where drainage cannot be achieved despite the opening of the posterior hyaloid, vitreoretinal surgery is required. In the study by Khadka et al. on a patient with Eales disease and retinal vein occlusion, despite the successful opening of the posterior hyaloid, the premacular haemorrhage did not drain into the vitreous and required

Table 3: *Case Features of Nd-YAG Laser Hyaloidotomy*

Case	Age/ gender	Symptom duration	Diagnosis	Shoot number	Max Energy (mj)	Additional
1	66/F	5	PDR	5	7	
2	72/F	2	PDR	2	5	
3	44/M	3	PDR	3	6	
4	62/F	5	PDR	3	8	
5	56/M	7	PDR	2	7	
6	64/F	15	PDR	8	12	PPV
7	64/M	22	PDR	4	7	
8	58/M	3	PDR	3	7	
9	59/M	5	PDR	5	3	
10	67/F	7	PDR	5	7	
11	68/F	8	PDR	4	6	
12	58/M	10	PDR	5	6	
13	63/F	21	PDR	7	11	PPV
14	40/M	7	HT CRISIS	1	5	
15	53/F	11	HT CRISIS	1	5	
16	22/M	7	VALSALVA	3	5	
17	35/F	3	VALSALVA	4	7	
18	58/M	23	VALSALVA	6	9	
19	27/M	7	VALSALVA	4	6	
20	82/F	27	VALSALVA	3	6	
21	10/M	1	LEUKEMIA	6	8	
22	12/M	7	LEUKEMIA	8	11	PPV
23	9/F	3	LEUKEMIA	5	8	
24	10/M	5	LEUKEMIA	4	9	
25	11/M	14	LEUKEMIA	3	7	
26	67/F	32	RVO	4	9	
27	74/M	3	RVO	5	8	
28	51/F	7	RVO	4	5	
29	63/F	10	RVO	3	7	
30	61/F	12	RVO	1	5	
31	53/M	11	RVO	5	8	
32	55/F	21	MA	4	6	
33	57/F	3	MA	5	7	
34	77/M	15	CNVM	6	9	
35	81/F	8	CNVM	3	9	
36	62/M	15	Terson	4	6	
36	62/M	15	Terson	5	5	
37	48/M	15	Terson	8	12	PPV
37	48/M	15	Terson	8	12	PPV

PDR:Proliferative Diabetic Retinopathy, HT: Hypertansive, RVO:Retinal vein occlusion, MA: Macroaneurysm, CNVM: choroidal neovascular membrane

PPV. In these patients, the size of the premacular haemorrhage was greater than ten disc diameters, and it was reported that the size of the haemorrhage may be a prognostic factor for the success of the procedure.[11]

Durukan et al. reported that a conservative approach would be more appropriate for haemorrhages smaller than three disc diameters owing to the risk of photo-disruptive damage due to the Nd-YAG laser.[9] In our study, the size of the SHH covered the macular area in all cases. However, the effect of haemorrhage size on final visual acuity was not evaluated. This is one of the limitations of our study.

Performing a PPV to remove the vitreous haemorrhage immediately offers the benefit of substantial and immediate enhancement of vision, and it may also avert complications that can arise from a prolonged haemorrhage. Nevertheless PPV, a common procedure, can lead to risks and complications, including the development of nuclear sclerotic cataract, retinal detachment, intraoperative tears, endophthalmitis, and postoperative proliferative vitreoretinopathy, causing significant visual function impairment.[3]

Hussain et al. histopathologically examined ILM tissues excised by vitrectomy in patients with sub-ILM haemorrhage. They found proliferative vitreoretinopathy like changes were more common in patients without early surgery. As a result, they recommended an early PPV approach in the treatment of sub-ILM haemorrhage.[18]

Our study's limitations include the fact that we did not evaluate the size of the SHH, whether the hemorrhage was subhyaloid or sub-ILM with optical coherence tomography, and the small number of patients who underwent vitrectomy.

In conclusion, Nd-YAG laser hyaloidotomy is a noninvasive, fast, and safe treatment for subhyaloid haemorrage, avoiding invasive surgery and complications. It allows early identification of retinal pathology and provides for necessary treatment. Pars plana vitrectomy is an effective option for vitreous haemorrhages that cannot be successfully drained or do not regress. The final visual prognosis depends on the etiology and associated macular changes.

THANKS

Conflict Of Interest

All authors read and agreed to publised version of the manuscript.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, Busra Guner Sonmezoglu, upon reasonable request.

Fundings

There isn't any funding to report for this submission

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