e-ISSN: 3023-6479

AOR

Volume: 1

Issue: 4

Year: 2024

Archives of Ophtalmological Research

MHA
MEDIHEALTH ACADEMY

Archives of
Ophtalmological Research

Editorial Board

Archives of
Ophtalmological Research

Editorial Board

ENGLISH LANGUAGE EDITOR

STATISTICS EDITOR

DESIGN

Şerife Kutlu
E-mail: mha.editoroffice@gmail.com

Archives of
Ophtalmological Research

Contents

Volume: 1 Issue: 4 Year: 2024

ORIGINAL ARTICLES

Archives of
Ophtalmological Research

Original Article

DOI: 10.51271/AOR-0016

Dexamethasone implantation causing iatrogenic lens injury: a review of literature with case series

Ali Dal[1], Murat Erdağ[2], Mehmet Canleblebici[3], Mehmet Balbaba[2], Hakan Yıldırım[2]

[1]Department of Ophthalmology, Faculty of Medicine, Mustafa Kemal University, Hatay, Turkiye
[2]Department of Ophthalmology, Faculty of Medicine, Fırat University, Elazığ, Turkiye
[3]Department of Ophthalmology, Kayseri State Hospital, Kayseri, Turkiye

Received: 25/08/2024 ◆ Accepted: 06/09/2024 ◆ Published: 23/10/2024

Cite this article: Dal A, Erdağ M, Canleblebici M, Balbaba M, Yıldırım H. Dexamethasone implantation causing iatrogenic lens injury: a review of literature with case series. *Arch Ophthalmol Res*. 2024;1(4):56-59.

Corresponding Author: Murat Erdağ, mderdag@gmail.com

ABSTRACT

Aims: In this study, three cases of iatrogenic lens injuries during Dexamethasone (DXM) implantation will be discussed, and current approaches will be reviewed with the literature.

Methods: Three patients with iatrogenic lens injury during DXM implantation were evaluated retrospectively.

Results: The two patients underwent DXM implantation for cystoid macular edema with central retinal vein occlusion and one patient for EALES disease. The surgical intervention was performed in all three patients in conjunction with cataract surgery. Intraocular lenses are implanted into the sulcus in all patients. The DXM could be directed to the vitreous in two patients, while the other patient underwent anterior vitrectomy and DXM explanation. Anti-vascular endothelial growth factor was injected in the patient who could not implant DXM. The lens was stable in all patients in postoperative controls. There was a decrease in macular thickness at follow-up.

Conclusion: The dexamethasone implant is a slow-release tablet for macular edema due to retinal vein occlusion, diabetic retinopathy and non-infectious uveitis. Lens injury during dexamethasone implantation is a rare complication. In our series, the implant occluded the visual axis and most of it was in the lens, managed with cataract surgery. If possible, DXM should be directed to the vitreous; if not, treatment modalities should be specificized on a patient-by-patient basis.

Keywords: Dexametasone implantation, Iatrogenic lens injury, iatrogenic cataract

INTRODUCTION

Dexamethasone implant (DXM) (Ozurdex® Allergan Inc, Irvine, CA, USA) is a rod-shaped, slow-release tablet containing 700µg of DXM. It is administered with a 22 gauge needle for macular edema due to retinal vein occlusion, diabetic retinopathy and non-infectious uveitis.[1,2] To avoid systemic side effects of corticosteroids, such drugs can be administered intravitreally. However, the short half-life of intravitreally administered corticosteroids requires frequent intraocular injections. To overcome this problem, intravitreal sustained-release dosage forms have been developed.

In the ZERO study of DXM implant, complications such as glaucoma and cataract endophthalmitis were reported, but crystalline lens injury was not reported.[3] There are rare case reports of crystalline lens injuries during implant injection.[4-6] This may be due to inexperience of the surgeon, surgical technique or the patient during the procedure.[7] Complications arising from the implant itself, such as fracture or displacement of the DXM implant into the anterior chamber, can also occur.[4,8]

When intralenticular DXM complications develop, some studies recommend follow-up, while others recommend immediate cataract surgery.[5,9] An alternative approach is a conservative approach in which phacoemulsification is not performed immediately unless there is a change in macular edema and worsening of visual acuity.[10] In this case series, we aimed to evaluate the approach to the patient with lens injury during DXM implantation and to discuss the complication management with patient-specific approaches in the light of the literature.

METHODS

The preoperative and postoperative findings of three patients who developed crystalline lens damage after intravitreal DXM implantation and underwent surgical treatment were retrospectively analyzed. In addition, intraoperative approaches were evaluated. Approaches in the surgical stages were discussed in detail with alternative orientations. A case series study, we do not have ethical commitee report. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

RESULTS

Case 1

A 62-year-old man was admitted to our clinic with blurred vision. One month ago, DXM implantation was performed in his left eye due to macular edema secondary to retinal vein occlusion. He had no systemic disease except hypertension which was controlled with medication. On ophthalmologic examination, best corrected visual acuity (BCVA) was 0.9 and 0.1 in the right and left eyes, respectively, according to the Snellen chart. Intraocular pressure was 14 mmHg in the right eye and 16 mmHg in the left eye. Anterior segment examination revealed grade 1 nuclear sclerosis in the right eye and dexamethasone implant in the left eye, which pierced the posterior capsule at the 2 o'clock level, extended to the anterior capsule and formed a sheen in the posterior capsule (Figure 1). Fundus examination revealed diffuse retinal hemorrhage in 4 quadrants of the left eye and cellophane maculopathy onset in the right and left fundus. Central macular thickness (CMT) was 289 micrometers (μm) in the right eye and 453 μm in the left eye.

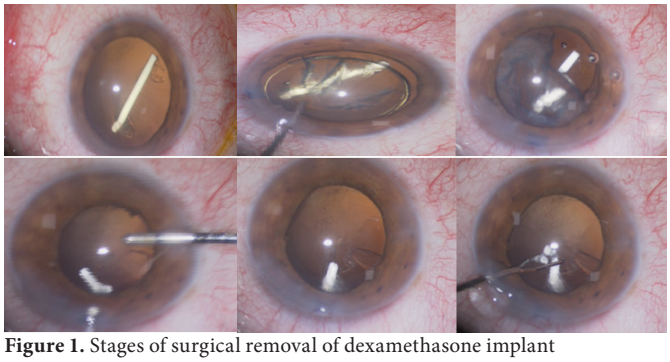

Figure 1. Stages of surgical removal of dexamethasone implant

Surgery was decided because of the implant occlusion of the optic axis and lens opacification. Hydrodelineation was performed in a controlled manner during surgery. The parameters of the phacoemulsification device were set as bottle height 60 cm water, phaco power 20%, aspiration power 250 mmHg. After the phacoemulsification procedure was completed, the implant fragments were cleaned with the help of irrigation/aspiration and the remaining residual fragments carefully maneuvered through the opening in the posterior capsule into the vitreous with the help of microforceps. It was observed that vitreous was not in the anterior chamber and the anterior hyaloid was intact. A 3-piece intraocular lens (IOL) was implanted in the sulcus and optical capture was performed. Postoperative follow-up showed that the IOL was stable and centralized. At the 1st month follow-up visit, the left eye BCVA was 0.5 and no change in CMT was observed with 13 mmHg IOP.

Case 2

The DXM implantation was recommended in a 47-year-old male patient with EALES disease for his right eye because macular edema persisted despite previous anti-vascular endthothelial growth factor (VEGF) treatment. After implantation, the lens was penetreted with DXM. The BCVAs were measured as 0.3 and 0.9 in the right and left eyes, respectively, according to the Snellen easel. Intraocular pressures were 14 mmHg in the right eye and 12 mmHg in the left eye. In the anterior segment examination, the anterior capsule extended to the anterior capsule by piercing the posterior capsule at 2-3 o'clock in the right eye and occluded the axis. The anterior segment examination of the left eye was normal. The fundus examination revealed diffuse retinal hemorrhage and panretinal photocoagulation scars in 4 quadrants in the right fundus, while the left eye was normal. Central macular thickness (CMT) was 630 μm in the right eye and 270 μm in the left eye.

In this case, hydrodelineation was performed in a controlled manner during surgery with gloden ring sign and similar phaco parameters were used as in the previous case. Afterwards, residual implant fragments were removed with a 23-gauge ocutome and anterior vitrectomy was performed with low cutting speed and some fragments of DXM were carefully maneuvered into the vitreous during the procedure. A 3-piece IOL was implanted to the sulcus (Figure 2). Perioperative anti-VEGF injection was performed due to macular edema. Postoperative visual acuity of the right eye was 0.5 and CMT was 453 μm at the 1st postoperative month with 13 mmHg IOP.

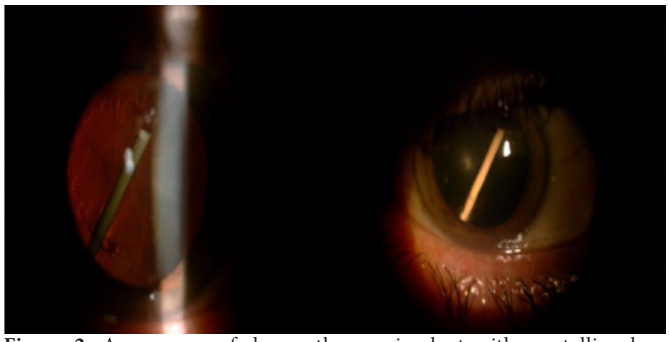

Figure 2. Appearance of dexamethasone implant with crystalline lens insertion on slit lamp

Case 3

A 61-year-old man was recommended DXM implantation for macular edema due to central retinal vein occlusion. During implantation in the left eye, it was observed that the implant penetrated the lens at 2-9 o'clock. (Figure 3) BCVA was 0.8 in the right eye and 0.1 in the left eye. The patient had bilateral nuclear sclerosis. Fundus examination of the left eye was unremarkable while diffuse retinal hemorrhages were observed in 4 quadrants in the left eye. Preoperative macular thickness in the left eye was 443 μm.

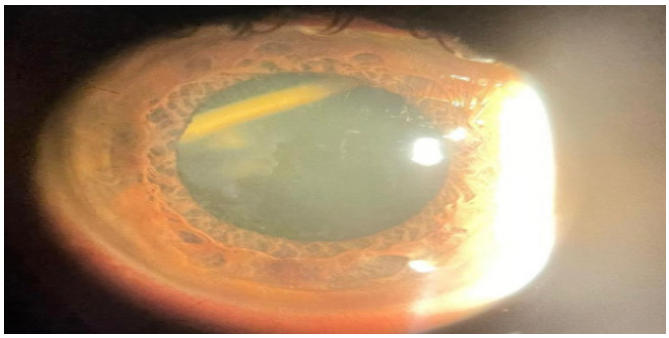

Figure 3. Dexamethasone implant lodged in the superonasal part of the lens

Cataract surgery was performed with the settings mentioned above. In this patient, the anterior hyaloid was intact and the lens was directed to the vitreous because the hole in the posterior capsule did not enlarge during the case. The IOL was implanted to the sulcus. At the 1st month post operative control, BCVA was 0.2 and the lens was stable and centralized and IOP was 14 mmHg. The control macular thickness was decreased to 317 μm

DISCUSSION

To avoid the systemic side effects of corticosteroids, such drugs can be administered intravitreally but require frequent injections due to the short half-life of corticosteroids. To overcome this, intravitreal sustained-release dosage forms have been developed.[11] Since the DXM implant is administered with a large 22 gauge syringe compared to the 28 or 30 gauge needles used for anti-VEGF therapy, there is relatively high compression of the eyeball during the procedure, which can lead to complications.[7]

In previous studies, the incidence of crystalline lens injury during implant injection was reported as 0.009%.[12] When intralenticular dexamethasone complications develop, some studies recommend follow-up, while others recommend immediate phacoemulsification for cataract.[5,9] If there is no significant increase in macular edema and no worsening of visual acuity, it is recommended that phacoemulsification is not performed immediately.[10] Patients with a conservative approach should be closely monitored for elevated IOP and endothelial toxicity. Cases with intralenticular implantation have been reported up to 12-20 months without cataract development.[7,13] Başkan et al.[14] reported that the dexamethasone implant, which is completely inside the lens, may not have a therapeutic effect, while Çiloğlu et al.[15] reported that there was no increase in macular edema in their case, they followed intralenticular dexamethasone until the 6th month and planned surgery upon the patient's complaint.

Patients who develop clinically significant cataract formation, sudden IOP increase or corneal decompensation after complications may require emergency surgery.[16] After phacoemulsification and IOL implantation, the implant can be repositioned or directed into the vitreous cavity[9] However, in this approach, implant fragments sent into the vitreous cavity may pass into the anterior segment due to the lack of integrity of the posterior capsule and may result in endothelial toxicity. Sometimes in patients who have undergone cataract or pars plana vitrectomy surgery and IOL implantation, the implant may pass into the anterior chamber even though the posterior capsule is intact.[17] Some authors have reported that the dexamethasone implant, which passes into the anterior chamber and is called 'traveling implant', can be positioned and sent to the posterior vitreous.[18] Caution is required if implants are to be used in patients with scleral fixation IOLs or zonule weakness due to aphakia, posterior capsule rupture. Alternative routes such as subtenon steroid injection should be preferred.[19]

Surgery was planned in our all cases because the implant occluded the optic axis and caused lens opacification. Another condition that should be evaluated before deciding on surgery is the size of the releasing part of the implant in the vitreous. In our cases, we thought that the drug may not reach the effective dose in the vitreous because the majority of the dexamethasone implant was in the lens.[14] In addition to topical anesthesia, subconjunctival, peribulbar or retrobulbar anesthesia should also be considered as alternatives considering that the operation time may be prolonged. As in our two cases, the anterior hyaloid can remain intact and the IOL can be implanted into the pulpus by an experienced surgeon without the need for anterior vitrectomy. This may provide advantages such as less complications such as Irvine-gass syndrome that may develop later.

The DXM implant should be directed to the vitreous in these cases if possible. This is advantageous for controlling inflammation and macular edema, as the drug is expensive. As in one of our cases, if the implant cannot be repositioned to the vitreous, alternative therapies such as anti-VEGF should be considered. The important points of the aproach for lens injury with DXM implantation is summarized with Table.

Table. Important points to be considered in cases of lens damage with DXM implant

Implant damage should be carefully evaluated.
The extent of posterior capsule damage and the presence of zonular damage should be well evaluated.
Preoperative visual acuity, the level of iatrogenic cataract, whether the visual axis is clear, the age of the patient, the condition of the lens opacification and how much of the implant is in the lens should be evaluated and cataract surgery should be planned.
Stronger anesthesia such as sub-tenon, retrobulbar or general anesthesia should be chosen.
Since there is a posterior capsule tear during surgery, hydro-delineation should be performed, and hydro-dissection should be avoided unless necessary.
Low bottle height, low phacoemulsification energy, frequent intervention with dispersive viscoelastic should be preferred and an experienced surgeon should manage the case.
The posterior capsule tear should not be widened and the anterior hyaloid should be kept intact, and if possible, the implant should be directed towards the vitreous.
If the implant cannot be saved, alternative treatment methods such as anti-VEGF should be considered.
Anterior vitrectomy can be applied when necessary.
If possible, the surgeon should consider IOL implantation in the sulcus.
If the IOL cannot be implanted in the implanted sulcus, secondary IOL implantation can be considered with different techniques.
Keeping the complications at a minimum level in these patients is important to reduce the effect of postoperative Irvine gass syndrome on macular edema.
Postoperative follow-ups should be careful in terms of complications such as IOP elevation, lens dislocation, posterior capsular opacification, increased macular edema, and endophthalmitis.

DXM: Dexamethasone implant, VEGF: Anti-vascular endthothelial growth factor, IOL: Intraocular lens

Limitations

Our study has limitations due to the small number of cases. However, these cases, even if sporadic, should be reported and future meta-analyses or reviews will provide a better understanding of the management of these cases.

CONCLUSION

In patients with lens damage during DXM implant administration, the amount of release may be inadequate with the part of the implant that remains outside the lens, depending on the size of the amount that enters the lens. These patients can be implanted with an IOL lens with careful and cautious cataract surgery. If possible, the implant should be directed into the vitreous. If the implant cannot be guided, alternative treatment methods should be considered.

ETHICAL DECLARATIONS

Ethics Committee Approval

A case series study, we do not have ethical commitee report.

Informed Consent

The written informed consents were obtained from the patients and their family for publication of this study and accompanying images.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Pacella F, Ferraresi AF, Turchetti P, et al. Intravitreal injection of Ozurdex (®) implant in patients with persistent diabetic macular edema, with six-month follow-up. *Ophthalmol Eye Dis.* 2016;8:11-16.
2. Lowder C, Belfort Jr R, Lightman S, et al. Dexamethasone intravitreal implant for noninfectious intermediate or posterior uveitis. *Arch Ophthalmol.* 2011;129(5):545-553.
3. Schmitz K, Maier M, Clemens CR, et al. Zuverlässigkeit und Sicherheit von intravitrealen Ozurdex-injektionen. Die ZERO-studie. *Ophthalmologe.* 2014;111(1):44-52. doi:10.1007/s00347-012-2737-2
4. Agrawal R, Fernandez-Sanz G, Bala S, et al. Desegmentation of Ozurdex implant in vitreous cavity: report of two cases. *Br J Ophthalmol.* 2014;98(7):961-963.
5. Poornachandra B, Kumar VBM, Jayadev C, et al. Immortal Ozurdex: a 10-month follow-up of an intralenticular implant. *Indian J Ophthalmol.* 2017;65(3):255-257.
6. Coca-Robinot J, Casco-Silva B, Armad Maresca F, et al. Accidental injection of dexamethasone intravitreal implant (Ozurdex) into the crystalline lens. *Eur J Ophthalmol.* 2014;24(4):633-666.
7. Regan K, Blake CR, Lukowski ZL, et al. Intralenticular Ozurdex- one year later. *Case Rep Ophthalmol.* 2017;8(3):590-594.
8. Khurana RN, Appa SN, McCannel CA, et al. Dexamethasone implant anterior chamber migration: risk factors, complications, and management strategies. *Ophthalmology.* 2014; 121(1):67-71.
9. Munteanu M, Rosca C. Repositioning and follow-up of intralenticular dexamethasone implant. *J Cataract Refract Surg.* 2013;39(8):1271-1274.
10. Sekeroglu MA, Anayol MA, Koc F et al. Intralenticular sustained-release dexamethasone implant: is it still effective on macular edema. *Case Rep Ophthalmol.* 2016;7(1):85-89.
11. Costello MA, Liu J, Wang Y, et al. Reverse engineering the Ozurdex dexamethasone intravitreal implant. *Int J Pharm.* 2023;634:122625.
12. Meyer CH, Rodrigues EB, Michels S, et al. Incidence of damage to the crystalline lens during intravitreal injections. *J Ocul Pharmacol Ther.* 2010;26(5):491-495.
13. Valverde-Megias A, Hernandez-Ruiz S, Cifuentes-Canorea P, et al. Intralenticular Ozurdex implant: what to do and how. *J Fr Ophthalmol.* 2018;41(4):149-150.
14. Baskan B, Cıcek A, Gulhan A, Gundogan M, Goktas S. Ozurdex completely located inside a crystallized lens-results of 14 months. *Am J Ophthalmol Case Rep.* 2016;4:38-40.
15. Çiloğlu E, İnan P. Intralenticular dexamethasone: a case report. *J Retina Vitreous.* 2021;30(2).
16. Fasce F, Battaglia PM, Knutsson KA, et al. Accidental injection of dexamethasone intravitreal implant in the crystalline lens. *Acta Ophthalmol.* 2014;92(4):330-331.
17. Kocak N, Ozturk T, Karahan E, Kaynak S. Anterior migration of dexamethasone implant in a pseudophakic patient with intact posterior capsule. *Indian J Ophthalmol.* 2014;62(11):1086-1088.
18. Srinivasan P, Jayadev C Shetty R. The nomadic Ozurdex®: anterior migration of the dexamethasone implant and back!. *Oman J Ophthalmol.* 2017;10(2):109-111.
19. Kumar A, Ambiya V, Kapoor G, Arora A. Wandering Ozurdex in eyes with scleral fixated intraocular lens and its management: a report of two cases. *J Curr Ophthalmol.* 2019;31(3):345-348.

Archives of
Ophtalmological Research

Original Article

DOI: 10.51271/AOR-0017

Efficacy of ChromaGen lenses in enhancing color perception in color vision deficiency: a critical evaluation

Mehmet Sait Günerigök[1], Özgür Bülent Timuçin[2], Ahmet Tuncer Özmen[3]

[1]*Department of Opthalmology, Medikalpark Bursa Hospital, Bursa, Turkiye*
[2]*Department of Opthalmology, Van Training and Research Hospital, Health Sciences University, Van, Turkiye*
[3]*Department of Ophthalmology, Faculty of Medicine, Uludağ University, Bursa, Turkiye*

Received: 01/09/2024 ◆ **Accepted**: 14/09/2024 ◆ **Published**: 23/10/2024

Cite this article: Günerigök MS, Timuçin ÖB, Özmen AT. Efficacy of ChromaGen lenses in enhancing color perception in color vision deficiency: a critical evaluation. *Arch Ophthalmol Res*. 2024;1(4):60-64.

Corresponding Author: Özgür Bülent Timuçin, bulenttimucin@gmail.com

ABSTRACT

Aims: Despite advancements in color vision correction, evidence supporting the efficacy of ChromaGen haploscopic filter systems in improving color perception remains limited. This study primarily investigates the performance of ChromaGen lenses (CL).

Methods: The study included 27 volunteers diagnosed with color vision deficiency (CVD). An anomaloscope was used to detect color vision defects. Participants underwent color vision tests (Ishihara and panel D15) both with and without CL. The results were statistically analyzed.

Results: All participants were male, aged 21 to 57. Among them, 12 (44%) had protan defect (10 protanopes, 2 protanomalies) and 15 (56%) had deutan defect (12 deuteranopes, 3 deuteranomalies). Without CL, protan defect participants read 2.0±1.0 pages on the Ishihara test, while deutan defect participants read 3.0±1.9 pages. With CL, protan defect participants read 4.5±2.2 pages and deutan defect participants read 14.2±0.9 pages, showing statistically significant improvement ($p<0.05$). The difference between protan and deutan groups was also statistically significant ($p<0.05$). In the panel D15 test, without the use of CL 81% of individuals with protanopia and deuteranopia made significant errors, whereas participants with protanomaly and deuteranomaly performed well. No significant improvement was noted with CL in the panel D15 results. Twenty-three participants preferred magenta and four preferred pink CL. Fifteen participants expressed interest in using CL solely to pass the Ishihara test.

Conclusion: This study concludes that commercially available ChromaGen filters do not provide clinically significant evidence of improved subjective color perception. Therefore, recommending these devices to the CVD population for color perception may not be highly beneficial. However, ChromaGen lenses may be used by some CVD patients to pass the Ishihara test.

Keywords: Color vision deficiency, ChromaGen lenses, anomaloscope, Ishihara test, panel D15 test, color vision correction, haploscopic filter systems

INTRODUCTION

Color vision deficiency (CVD) presents significant challenges in daily life particularly affecting tasks that require accurate color discrimination. Patients with CVD encounter important vocational limitations in various industries. Unfortunately, the options available to assist individuals with CVD are limited. Despite several recent innovations,[1-6] there remains a notable lack of clinical evaluations and interventional studies assessing the efficacy of these devices. Existing research is sparse and often confined to case reports, highlighting a critical gap in our understanding of their potential benefits.[7]

ChromaGen lenses (Chromagen Ltd, Chester, UK) represent a recent advancement in contact lens technology. These lenses have shown promise in enhancing color perception for individuals with red-green color vision impairments.[1,8] This study aims to explore the effectiveness of ChromaGen lenses (CL) particularly in improving color vision scores and subjective visual experiences to provide deeper insights into their role as a viable solution for managing CVD. Through a comprehensive review of current literature and clinical observations we seek to establish a foundational understanding of how CL can be integrated into therapeutic practices for patients with color vision deficiency.

METHODS

This prospective study was conducted at the ophthalmology department of a single tertiary hospital, adhering to the Declaration of Helsinki throughout the study, and was approved by the Bursa Uludağ University Clinical Researches

Ethics Committee (Date: 11.09.2007, Decision No: 2007–14/43). After providing verbal information about the study, written informed consent was obtained from all participants.

Volunteers with CVD were included in the study, while individuals with corrected visual acuity less than 2/10 in one eye or 12/20 for both eyes combined, as well as those with night blindness, diplopia, paralytic strabismus, visual field defects, cataracts, macular degeneration, retinopathy or monochromatic and achromatic vision were excluded. Detailed histories, including age, gender, occupation and age of diagnosis were recorded. Comprehensive eye examinations and color vision tests were conducted and participants' experiences with color vision in daily and professional life were documented.

Color vision was assessed using the Anomaloscope, Ishihara and panel D15 tests. The Anomaloscope was initially employed to confirm the diagnosis and subtype of color blindness through Rayleigh matching. Rayleigh color matching data were collected on CVD participants using an Oculus HMC Anomaloscope. Participants were categorized into Protan and Deutan groups.

The Ishihara test (published in 1978) were administered without CL first, followed by a repeat of the tests with CL. Errors were assessed with natural vision, and results were recorded after repeating the tests with CL to evaluate their effectiveness. Fifteen Ishihara plates were held 75 cm from the subjects. All subjects were asked to identify the symbols on plates 2-15, responding without more than a three-second delay. The first plate was excluded from evaluation as it was designed for both normal vision and all types of CVD. The number of recognized symbols on the 15 consecutive plates was noted for each participants.

Panel D15 test were administered without CL first, followed by a repeat of the tests with CL. Panel D15 errors were assessed with natural vision and results were recorded after repeating the tests with CL to evaluate their effectiveness. The panel D-15 hue Test consists of 15 color caps selected from various parts of a color circle contained in a box. There is one fixed reference color cap that is blue. The participant is asked to arrange the 15 color caps in the order of perceived similarity, starting from the reference cap. Once the test is completed the box is closed and turned upside down. The numbers on the back of the color caps are then checked to evaluate how the participant arranged them.

Standard plano CL with a 6 mm pupil diameter and an 8.6 mm base curve were utilized. Refractive errors were corrected with glasses. Initially participants performed the Ishihara test with one eye using a ChromaGen filter to determine the dominant eye. Filters were then applied to the non-dominant eye and adjustments were made based on performance improvements. The same filter was applied to the dominant eye and participants explored colorful environments for one hour to assess subjective changes in color perception. None of the patients in the study were previous contact lens wearers. The Ishihara and panel D15 tests were repeated with the selected CL and results were recorded. Participants were subsequently asked about their interest in purchasing and using the lenses regularly.

Statistical Analysis

Statistical analysis was performed using SPSS 13.0. Differences in Ishihara test results with and without ChromaGen lenses for all patients (protan and deutan) were evaluated using the Wilcoxon test. Comparisons between the two groups were conducted using the Mann-Whitney U test, with statistical significance set at $p<0.05$.

RESULTS

All participants were male, aged between 21 and 57 with an average age of 30.55. Of the 27 participants 25 had previously been diagnosed with color blindness at other healthcare institutions. The anomaloscope test identified 10 protanopes, 2 protanomalous individuals, 12 deuteranopes and 3 deuteranomalous individuals. The significant errors made by all participants in the Ishihara test confirmed red-green color blindness but did not distinguish the type of blindness. Participants with deutan deficiency read between 1 and 8 of the 15 Ishihara plates in the first stage while participants with protan deficiency read between 1 and 4 plates. Protanopic and deuteranopic individuals made significant errors in the panel D15 test. However protanomalous and deuteranomalous participants performed well (Table 1). With CL deuteranopic individuals read between 12 and 15 plates (Table 2, Figure 1), while participants with protan deficiency read between 2 and 9 plates (Table 3, Figure 2).

Table 1. Anomaloscope, Ishihara, and panel D 15 test results

Patient number	Diagnosis in anomaloscope test	Pages correctly read in Ishihara test	Panel D15 results
1	Protanopia	4/15	Abnormal
2	Protanopia	1/15	Abnormal
3	Protanopia	3/15	Abnormal
4	Protanopia	2/15	Abnormal
5	Protanopia	1/15	Abnormal
6	Protanopia	3/15	Abnormal
7	Protanopia	1/15	Abnormal
8	Protanopia	1/15	Abnormal
9	Protanopia	1/15	Abnormal
10	Protanopia	2/15	Abnormal
11	Protanomaly	3/15	Normal
12	Protanomaly	3/15	Normal
13	Deuteranopia	2/15	Abnormal
14	Deuteranopia	3/15	Abnormal
15	Deuteranopia	3/15	Abnormal
16	Deuteranopia	3/15	Abnormal
17	Deuteranopia	1/15	Abnormal
18	Deuteranopia	5/15	Abnormal
19	Deuteranopia	1/15	Abnormal
20	Deuteranopia	2/15	Abnormal
21	Deuteranopia	2/15	Abnormal
22	Deuteranopia	2/15	Abnormal
23	Deuteranopia	2/15	Abnormal
24	Deuteranopia	2/15	Abnormal
25	Deuteranomaly	6/15	Normal
26	Deuteranomaly	4/15	Normal
27	Deuteranomaly	8/15	Normal

Table 2. Ishihara test results and error amounts before and after the application of ChromaGen lens in patients with deutan defect

ID	Anomaloscope results without ChromaGen lens	Ishihara results without ChromaGen lens	Ishihara error amount without ChromaGen lens	Ishihara results with ChromaGen lens	Ishihara error amount with ChromaGen lens
1	Deuteranopia	2/15	13	14/15	1
2	Deuteranopia	3/15	12	15/15	0
3	Deuteranopia	3/15	12	14/15	1
4	Deuteranopia	3/15	12	15/15	0
5	Deuteranopia	1/15	14	15/15	0
6	Deuteranopia	5/15	10	14/15	1
7	Deuteranopia	1/15	14	14/15	1
8	Deuteranopia	2/15	13	13/15	2
9	Deuteranopia	2/15	13	12/15	3
10	Deuteranopia	2/15	13	15/15	0
11	Deuteranopia	2/15	13	13/15	2
12	Deuteranopia	2/15	13	14/15	1
13	Deuteranomali	6/15	9	15/15	0
14	Deuteranomali	4/15	11	15/15	0
15	Deuteranomali	8/15	7	15/15	0

Table 3. Ishihara test results and error amounts for patients with protan defect before and after applying ChromaGen lens

Patient number	Anomaloscope results	Ishihara results without ChromaGen lens	Ishihara errors without ChromaGen lens	Ishihara results with ChromaGen lens	Ishihara errors with ChromaGen lens
1	Protanopia	4/15	11	8/15	7
2	Protanopia	1/15	14	2/15	13
3	Protanopia	3/15	12	5/15	10
4	Protanopia	2/15	13	2/15	13
5	Protanopia	1/15	14	5/15	10
6	Protanopia	3/15	12	9/15	6
7	Protanopia	1/15	14	4/15	11
8	Protanopia	1/15	14	3/15	12
9	Protanopia	1/15	14	2/15	13
10	Protanopia	2/15	13	4/15	11
11	Protanomaly	3/15	12	5/15	10
12	Protanomaly	3/15	12	5/15	10

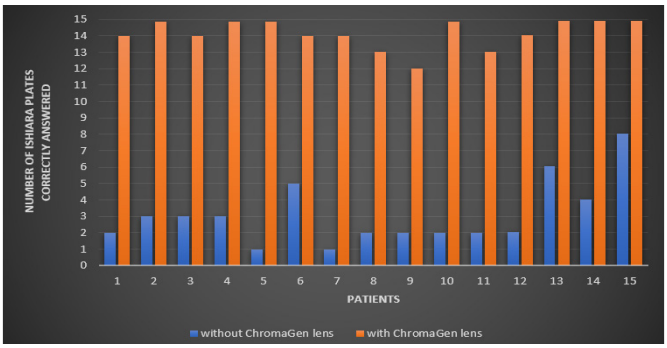

Figure 1. The number of pages correctly identified by participitants with Deutan defect in the first and second stages of the Ishihara test (p<0.05)

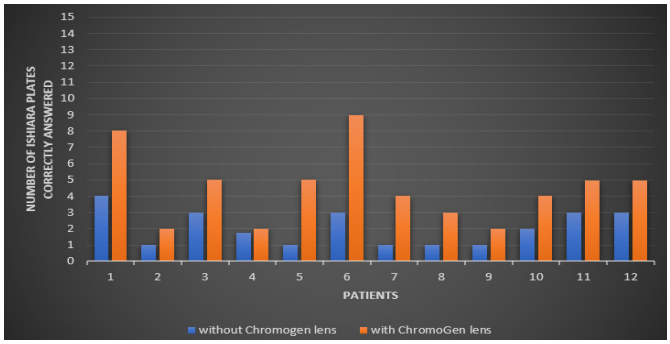

Figure 2. The number of plates correctly identified by participitants with Protan defect in the first and second stages of the Ishihara test (p<0.05)

Under natural conditions the average number of plates read correctly in the Ishihara test was 2.7±1.6 and the average number of errors was 12.3±1.6. With CL the average number of plates read increased to 9.8±5.1 and the number of errors decreased to 5.1±5.1. The difference between the tests conducted with and without CL was statistically significant (p<0.05).

Participants with protan deficiency read 2.0±1.0 plates without CL while participants with deutan deficiency read 3.0±1.9 plates. With CL, participants with protan deficiency read 4.5±2.2 plates and participants with deutan deficiency read 14.2±0.9 plates. The increase in the number of plates read and the decrease in the number of errors were statistically significant for both groups (p<0.05). No improvement was observed in the panel D15 test results with CL.

Twenty-three participants preferred magenta lenses while four participants chose pink lenses. While magenta lenses were not noticeable from the outside pink lenses were clearly visible. Participants reported experiencing difficulties in professional activities involving colors but did not encounter any issues in daily life other than naming colors. Although CL caused colors to appear brighter and also made the surroundings appear darker and pinkish. This situation was found to be disturbing by the participants. Fifteen

participants considered purchasing the lenses but only four participants thought about using the lenses to improve color perception. The others only wanted the lenses to pass the Ishihara test.

DISCUSSION

Color vision deficiency (CVD) impacts about 8% of the population. Among individuals with CVD, 6% exhibit trichromat anomalies, while 2% are classified as dichromats.[9] In this study, 22 participants were identified as dichromats, and 5 were classified as having trichromat anomalies. Due to the small sample size and the more pronounced color perception issues experienced by dichromat individuals[10] in professional life, we believe that our volunteer group does not reflect the prevalence rates of CVD in the general population.

In this study, the use of ChromaGen lenses (CL) increased the average number of correctly recognized Ishihara cards. Similarly, previous studies have shown that the addition of CL increases the number of correctly recognized cards.[11,12] However, in some individuals with CVD, this increase was limited. Those with limited increase had a protan defect and their CVD was found to be severe. In our study, participants with protan or deutan defects were unable to succeed in the Ishihara test without CL. However, after the application of CL, those with protan defects were able to read between 2 and 9 cards. Among the 14 participants with deutan defects, 93% were able to read 13 or more cards with CL, while 7% could read 12 cards. Participants with protan defects were unable to achieve success with CL, while 93% of those with deutan defects succeeded with the lenses.

The Ishihara test is typically used for screening. It is inadequate for determining the type and severity of color vision deficiency. For a more advanced evaluation of color vision deficiency, tests like panel D-15 and FM-100 are more useful. In this study, the effectiveness of CL was evaluated using the panel D15 test. Participants diagnosed with deuteranomaly and protanomaly (5 individuals) succeeded in the panel D15 test without CL, while those diagnosed with deuteranopia and protanopia did not succeed. Our finding that CL does not affect panel D15 test results is consistent with the findings of Swarbrick and colleagues.[1] Many studies have reported significant improvements in color perception with CL. However, Swarbrick et al.[1] found no clinical improvement in the lantern test. They reported that 78% of the test group succeeded in the Ishihara test with CL; error rates in all patients with deutan defects fell to 2 or below, and about half of the participants with protan defects achieved the same success. The ineffectiveness of CL in the lantern and panel D15 tests suggests that these lenses do not aid in color recognition and naming, indicating their unsuitability for professions where safety is critical.

Limitations

ChromaGen lenses offer a wider range of colors and intensities compared to other contact lens models designed for individuals with color vision deficiency (CVD). Studies report that participants using CL tend to prefer magenta, pink or purple lenses.[8] Similarly, in our study, 23 participants preferred magenta lenses, while 4 chose pink lenses. This suggests that the range of usable colors in the ChromaGen filter system is limited.

In our study, 14 out of 15 participants with deutan defects (93%) succeeded in the Ishihara test with CL. However, we believe this success is artificial. The success of color vision deficient patients in the Ishihara test can be explained by ChromaGen filters altering the color dots on the cards, allowing some participants to see hidden numbers or shapes. Indeed, similar studies have reported this effect as artificial. The fact that our participants with deutan defects succeeded in the Ishihara test with CL but did not achieve success in the panel D15 test indicates that CL has no effect on color perception.

CONCLUSION

While CL enable individuals with CVD to pass the Ishihara test, they do not alter color perception. More than half of the participants (15/27) reported that the sole purpose of using CL was to pass the Ishihara test. Our study anticipates that the use of assistive devices like CL during CVD assessment may raise certain ethical and legal issues. In summary:

- **Legal definition of color blindness:** Current legal regulations do not clearly define how color blindness should be assessed. This situation creates legal uncertainty when an individual passes the Ishihara test with CL but is still classified as color blind (Figure 3).

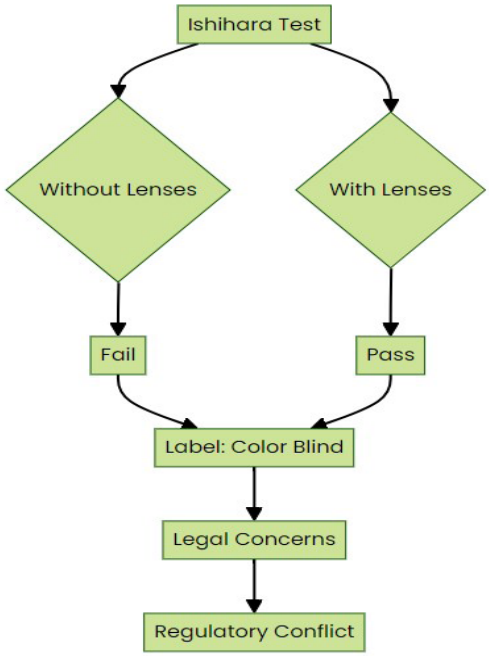

Figure 3. ChromaGen lenses with Ishihara test pathway: challenges and legal implications

- **Principle of legal certainty:** The absence of a clear legal provision on how the Ishihara test should not be passed may make it seem contrary to the principle of legal certainty, which requires laws to be applied in a clear and consistent manner.
- **Equality in assessment:** The use of CL creates disparities in how color vision deficiencies are assessed. Without clear legal provisions on the method of assessment, the use of CL could lead to unfair advantages or disadvantages in professions requiring specific color vision standards.
- **Lack of standardized guidelines:** Insufficient legal guidelines regarding the use of CL in assessments may lead to inconsistent practices among healthcare providers.

- **Ethical considerations:** The ethical implications of labeling individuals as "color blind" based on their performance with or without CL may raise questions about fairness and the integrity of the assessment process.
- **Impact on employment and licensing:** Misclassification due to the use of CL could affect employment opportunities or licensing in professions requiring specific color vision standards, potentially leading to legal challenges related to discrimination.
- **Absence of legal precedents:** The lack of established legal precedents regarding the use of CL in color vision assessments may lead to uncertainty for practitioners, patients and legal authorities.

Addressing these conflicts may require updates to regulations and clearer definitions regarding the assessment of color vision with CL. Therefore, based on our study data, we recommend adding the phrase "without corrective optical devices for color blindness" to all legal texts that stipulate the condition of "not having color blindness" to address these significant issues effectively.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Bursa Uludağ University Clinical Researches Ethics Committee (Date: 11.09.2007, Decision No: 2007–14/43).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Swarbrick HA, Nguyen P, Nguyen T, Pham P. The ChromaGen contact lens system: colour vision test results and subjective responses. *Ophthalm Physiol Opt*. 2001;21(3):182-196.
2. Gómez-Robledo L, Valero EM, Huertas R, Martínez-Domingo MA, Hernández-Andrés J. Do EnChroma glasses improve color vision for color blind subjects?. *Opt Express*. 2018;26(22):28693-28703.
3. Elsherif M, Salih AE, Yetisen AK, Butt H. Contact lenses for color vision deficiency. *Adv Mater Technol*. 2021;6(1):2000797.
4. Salih AE, Elsherif M, Alam F, Yetisen AK, Butt H. Gold nanocomposite contact lenses for color blindness management. *ACS Nano*. 2021;15(3):4870-4880.
5. Roostaei N, Hamidi SM. Two-dimensional biocompatible plasmonic contact lenses for color blindness correction. *Sci Rep*. 2022;12(1):1-8.
6. Sutton J, Langlotz T, Plopski A. Seeing colours: addressing colour vision deficiency with vision augmentations using computational glasses. *ACM Trans Comput-Hum Inter*. 2022;29(3):1-53.
7. Male SR, Shamanna BR, Bhardwaj R, Bhagvati C, Theagarayan B. Color vision devices for color vision deficiency patients: a systematic review and meta-analysis. *Health Sci Rep*. 2022;5(5):e842. doi:10.1002/hsr2.842
8. Ilhan C, Sekeroglu MA, Doguizi S, Yilmazbas P. The effect of the ChromaGen contact lens system on visual performance. *Clin Exp Optom*. 2020;103(4):507-512. doi:10.1111/cxo.13011
9. Simunovic MP. Color vision deficiency. *Eye (Lond)*. 2010;24:747-755.
10. Ceyhan D, Yaşar T. Renk görme ve sağlık kurulu işlemleri. *Turk J Ophthalmol*. 2011;41(1):35-42. doi:10.4274/tjo.41.07
11. González-Pérez J, Rodríguez Daporta E, Mira J. Case report: effect of haploscopic filter on contrast sensitivity function and color vision tests. *Optom Vis Sci*. 2020;97(12):1034-1040.
12. Harris D. Colouring sight: a study of CL fitting with colour-enhancing lenses. *Optician*. 1997;213:38-41.

Archives of
Ophtalmological Research

Original Article

DOI: 10.51271/AOR-0018

Combined evaluation of visual field and optical coherence tomography angiography data in multiple sclerosis patients

Selma Meşen, Ali Meşen, Musa Muzafferzade

Department of Ophthalmology, Health Practice and Research Hospital, Kahramanmaraş Sütçü İmam University, Kahramanmaraş, Turkiye

Received: 14/09/2024 ◆ **Accepted**: 22/09/2024 ◆ **Published**: 23/10/2024

Cite this article: Meşen S, Meşen A, Muzafferzade M. Combined evaluation of visual field and optical coherence tomography angiography data in multiple sclerosis patients. *Arch Ophthalmol Res*. 2024;1(4):65-68.

Corresponding Author: Selma Meşen, drselmamesen@gmail.com

ABSTRACT

Aims: To evaluate Humphrey visual field analyzer (HVFA) data and optical coherence tomography angiography (OCT-A) parameters in multiple sclerosis (MS) patients with optic neuritis (ON) attacks.

Methods: 34 eyes of 34 patients with MS diagnosis who had ON attacks were included in the study. After detailed ophthalmoscopic examination, OCT-A and HVFA images were taken. Spearman correlation analysis was used in statistical analysis.

Results: The mean age of the participants was 31.52±10.09 years. In the correlation analysis, a moderate correlation was found between mean deviation (MD) and foveal deep blood flow (DF) (rho=0.52), and a weak correlation was found between MD and foveal superficial blood flow (SF) (rho=0.40) and optic disc head blood flow (ODF) (rho=0.38). A weak negative correlation was found between pattern standard deviation (PSD) and DF (rho=-0.37) and ODF (rho=-0.40).

Conclusion: This study showed that OCTA data were affected in a manner consistent with HVFA data. More practical and quickly applicable OCTA scans may facilitate the estimation of visual field findings in MS patients.

Keywords: Multiple sclerosis, visual field, optic neuritis, optical coherence tomography angiography

INTRODUCTION

Multiple sclerosis (MS) is an inflammatory and neurodegenerative disease characterized by axonal loss in the central nervous system.[1] MS occurs mostly in young adults between the ages of 20 and 40, and women are affected more frequently than men. In the clinical course of MS, the most common ocular manifestation is optic neuritis (ON). ON occurs as the first symptom in approximately 20% of these patients.[2]

Recently, retinal imaging has been used to help understand the pathogenesis and follow the disease in central nervous system degeneration. Optical coherence tomography angiography (OCT-A) is a high-resolution, noninvasive method that visualizes blood flow in the retinal vascular structures. In addition to neurodegeneration, cerebral endothelial dysfunction has been detected in MS patients. Decreases in retinal vascular density and optic disc head blood flow indices detected by OCT-A were observed in MS patients.[3]

Visual field (VF) scans provide important information in the evaluation and follow-up of diseases affecting the visual pathways. Naumovska et al.[4] performed VF scans to evaluate the effectiveness of corticosteroid treatment in MS patients with ON attacks. At the end of the study, they revealed that there was no difference in the results of corticosteroid treatment administered orally or systemically. The VF test, which should be applied at certain intervals in MS disease, may be suboptimal depending on the performance of the participants and may need to be repeated.

This study aimed to investigate whether there is a correlation between Humphrey visual field analyzer (HVFA) data and OCT-A parameters in MS patients diagnosed with optic neuritis attacks.

METHODS

This study was conducted at Kahramanmaraş Sütçü İmam University Faculty of Medicine campus between June 2024 and September 2024. It was conducted following the principles of the Declaration of Helsinki with the approval of the Kahramanmaraş Sütçü İmam University Faculty of Medicine Ethics Committee (Date: 27.08.2024, Decision No: 210).

In this study, medical records of patients followed up with MS diagnosis were reviewed. Clinical features of ON include

painful or painless subacute monocular or binocular vision loss worsening with eye movements, decreased color vision, and relative afferent pupillary defect (RAPD). Symptoms supporting the diagnosis of ON include acute swelling of the optic disc, increased contrast in the optic nerve and its sheath on magnetic resonance imaging (MRI) of symptomatic patients, delayed P100 wave latency on visual evoked potential (VEP) testing, and deterioration on visual field testing. The presence of these pathologies was considered as having had an ON attack.[5]

Inclusion criteria were having MS between the ages of 18 and 80 years, having had an ON attack, complying with the study procedure (visual field and OCT-A scan), having a visual acuity of at least 20/200, not having had any ON or MS attack for at least three months, and not having used systemic or topical corticosteroid therapy for at least three months. Exclusion criteria were having a refractive status greater than -6.00 and +6.00 diopters in spherical equivalent in both eyes, having a history of intraocular surgery or orbital trauma, and having any additional ophthalmologic pathology (e.g. glaucoma, diabetic retinopathy, hypertensive retinopathy, or age-related macular degeneration). Patients with poorly documented, low-resolution OCT-A images were excluded from the study. Patients who could not adapt to visual field scans had fixation loss of more than 20%, and false positive (FP) and/or false negative (FN) rates of more than 33% were not included in the study. The eye of each participant who met the inclusion criteria for both eyes and had the first attack was included in the study.

A total of 34 eyes of 34 MS patients met the inclusion criteria. All patients underwent a complete ophthalmic examination, including best-corrected visual acuity (BCVA) testing using the Snellen chart (converted to logMAR), color vision examination (Ishihara test), RAPD examination, intraocular pressure measurement using Goldmann applanation tonometry, biomicroscopic anterior segment and dilated fundus examination. After the examination, images were obtained with spectral-domain OCT-A RTVue XR AngioVue (version 2015.1.0.90; Optovue, Inc., Fremont, CA, USA). Visual field acquisitions were performed with the HVFA (Carl Zeiss Meditec, Dublin, CA) at least 2 days later to allow dilation to resolve.

Optical Coherence Tomography Angiography Imaging

Before the OCT-A scan, all patients' pupils were dilated using a combination of 0.5% tropicamide and 2.5% phenylephrine HCL. OCT-A scans were performed by two experienced ophthalmologists (A.M. and S.M.). The OCT-A RTVue XR AngioVue, a spectral domain device based on the erythrocyte motion-dependent split-spectrum amplitude-correlated angiography (SSADA) algorithm, was used for imaging. This device provides volumetric exposure of 304×304 A at 70,000 a-scans per second with an 840 nm light source with a 5 mm axial resolution. The device performs quantitative analysis of the measured data and calculates vascular density and flow area.

Visual Field Imaging

All subjects underwent visual field testing with Humphrey's Field Analyzer 750 I (Carl Zeiss-Humphrey Systems, Dublin, California, USA) using the 30-2 SITA-Fast strategy. Visual fields were considered satisfactory when FP and FN errors did not exceed 33% and fixation errors did not exceed 20%.

The results obtained with HVFA were expressed in three ways: mean deviation (MD), pattern standard deviation (PSD), and the number of significantly depressed test points (DP) at <1% level on the pattern deviation probability map. MD is the mean of the difference between the patient's threshold value and the age-matched control group. PSD indicates the standard deviation of the difference between the threshold values and the expected threshold values in the visual field. It is an indicator of localized defects in the age-corrected area. The indicators of DP on the pattern deviation map are the probability that the obtained values would be found in the current population in this age group. A DP indicates that 99% of normal subjects of the same age would be expected to have a higher sensitivity than the recorded value. This is considered to provide a more sensitive measure of visual field defects than MD. To obtain the DP value, HVFA 30-2 was analyzed by counting and summing the number of significantly DP.

Statistical Analysis

The SPSS (Statistical Package for the Social Sciences; version 23) software program was used for the statistical analysis of the data obtained in this study. Descriptive statistics for the continuous variables were expressed as means ± standard deviations and medians (min-max), while categorical variables were expressed as numbers and percentages. Whether the data conformed to a normal distribution was determined using Kolmogorov-Smirnov and Shapiro-Wilk tests. Spearman correlation coefficients were calculated, and a statistical significance level of $p<0.05$ was accepted.

RESULTS

Demographic and Clinical Features

Of the 34 participants, 6 (17.6%) were male and 28 (82.3%) were female. The mean age was 31.52±10.09 years. The mean BCVA values were 0.10±0.04 (logMAR). Color vision test revealed defects in 11 (32.3%) patients. Additionally, 11 (31.4%) patients had RAPD. Detailed fundus examination revealed optic disc pallor in 15 (44.1%) patients (Table 1).

Table 1. Demographic characteristics of the patients

	MSON+ (n=34)
Age (mean±SD)	31.52±10.09
Gender n (%)	
Male	6 (17.6%)
Female	28 (82.3%)
BCVA (logMAR)	0.10±0.04
Color vision test n (%)	
Affected	11 (32.3%)
Normal	23 (67.6%)
RAPD n (%)	
Positive	11 (32.3%)
Negative	23 (67.6%)
Fundus examination n (%)	
Optic disc pathology	15 (44.1%)
Normal	19 (55.8%)

MSON: Multiple sclerosis optic neuritis attack, SD: Standard deviation, BCVA: Best corrected visual acuity, RAPD: relative afferent pupillary defect

OCT-A and HVFA Measurement Values

The means of OCT-A and HVFA data are given in Table 2. In the correlation analysis, a moderate correlation was found between MD and foveal deep blood flow (DF) (rho=0.525) ($p<0.05$), a weak correlation was found between MD and foveal superficial blood flow (SF) (rho=0.405) (p=0.03), and optic disc head blood flow (ODF) (rho=0.382) (p=0.04). A weak negative correlation was found between PSD and foveal DF (rho=-0.375) (p=0.04) and ODF (rho=-0.400) (p=0.03). There was also a moderate correlation between DP and ODF (rho=-0.528) ($p<0.05$) and a weak negative correlation between DP and DF (rho=-0.407) (p=0.03) was detected. (Table 3).

Table 2. Mean values of OCT-A and HVFA data of MS patients

	MSON+ (mean±SD) (n=34)
SF (μm²)	1.306±0.132
DF (μm²)	1.277±0.232
CCF (μm²)	1.893±0.052
sFAZ (μm²)	0.325±0.096
dFAZ (μm²)	0.414±0.163
Fovea sVD (%)	29.639±5.803
Parafovea sVD (%)	46.188±5.937
Fovea dVD (%)	32.848±8.049
Parafovea dVD (%)	56.648±7.663
ODF (μm²)	1.449±0.211
ONHD (%)	53.170±5.309
MD (dB)	-6.870±5.327
PSD (dB)	3.133±2.045

OCT-A: Optical coherence tomography angiography, HVFA: Humphrey visual field analyzer, MS: Multiple sclerosis, MSON: Multiple sclerosis optic neuritis attack, SD: Standard deviation, SF: Superficial flow, DF: Deep flow, CCF: Choriocapillaris flow, sFAZ: Superficial foveal avascular zone, dFAZ: Deep foveal avascular zone, sVD: Superficial vascular density, dVD: Deep vascular density, ODF: Optic disk flow, ONHD: Optik nerve head dansite, MD: Mean deviation, PSD: Pattern standard deviation, dB: Decibel

Table 3. Correlation coefficients of OCT-A and HVFA data

		SF (μm²)	DF (μm²)	ODF (μm²)
MD (dB)	Correlation coefficient	0.405	0.525	0.382
	p value	0.03	0.00	0.04
PSD (dB)	Correlation coefficient	-0.233	-0.375	-0.400
	p value	0.23	0.04	0.03
DP (<1%)	Correlation coefficient	-0.187	-0.407	-0.528
	p value	0.34	0.03	0.00

OCT-A: Optical coherence tomography angiography, HVFA: Humphrey visual field analyzer, SF: Superficial flow, DF: Deep flow, ODF: Optic disk flow, MD: Mean deviation, PSD: Pattern standard deviation, DP: Depressed test points, dB: Decibel

DISCUSSION

In this study, it was determined that MD, PSD, and DP data obtained from visual field output in MS patients with ON attacks were correlated with foveal SF, DF, and ODF data in OCT-A.

Visual dysfunction is common in MS. This is due to retrobulbar optic neuritis, papillitis, or rarely, demyelinating lesions affecting the retrochiasmal pathways. MS patients with ON attacks develop retinal ganglion cell axon loss.[6] Cheng et al.[7] studied the relationship between VF parameters and retinal nerve fiber layer (RNFL) thickness measured by optical coherence tomography (OCT) in MS patients. Pearson correlation coefficients between MD and RNFL thicknesses were found between 0.65 and 0.69 in eyes with ON attacks. However, no agreement was found between the two parameters in eyes without ON attacks. Khalil et al.[8] compared the mean RNFL thickness and MD parameters in VF in 68 MS patients but did not find a significant correlation. They attributed this result to the fact that OCT parameters may indicate subclinical permanent damage despite the VF parameters returning to near-normal levels after the ON attack. In another study comparing anatomical and functional parameters in MS cases, a correlation was found between macular sensitivity determined by microperimetry and macular volume from OCT parameters.[9]

Vascular abnormalities occur in MS patients due to cerebral endothelial cell dysfunction.[10] Based on these findings, retinal microvascular blood flow parameters of MS patients were examined. Wang et al.[11] revealed that there was a decrease in optic disc head flow indices in MS patients who had ON attacks compared to healthy controls. Similarly, decreased vascular density in the perifoveal area was reported in these patients.[3,12] A decrease in superficial and deep capillary vascular density was observed in the optic disc head and macula region in MS patients with or without ON attacks. This result was associated with MS disease activity independently of ON attacks. The authors suggested that the decrease in ganglion cell layer and nerve fiber layer in MS causes retinal hypoxia.[13] The decrease in vascular density in MS patients may be the result of inflammation-related endothelial dysfunction. Another hypothesis is that it may be related to decreased oxygen and metabolite demand due to neuroaxonal degeneration and nerve fiber layer atrophy.[14]

The ganglion cell complex, the nerve fiber layer, the ganglion cell layer, and the inner plexiform layer, are associated with the central nervous system. They are used to determine retinal effects associated with neurological diseases.[8] From OCT-A data, SF represents the blood flow between the internal limiting membrane and the inner plexiform layer. DF is the blood flow between the inner and outer plexiform layers. In the present study, a correlation was found between SF and MD. This result suggested that the decrease in vascular flow in the superficial layers may contribute to the damage in the ganglion cell complex. However, DF was found to be more correlated with VF parameters (MD, PSD, and DP). This finding supports the hypothesis that systemic vascular pathologies may develop in MS and that vascular pathologies may be associated with neuronal dysfunction and degeneration.[15] ODF was correlated with MD, PSD, and DP. In MS patients who have had an ON attack, hemodynamic disorders may develop in the central retinal artery, and optic disc blood flow may decrease.[16] In addition, since axonal loss will develop in the optic nerve after the attack, both OCT-A and VF values will be affected in these cases.

Limitations

The current study includes the limited number of patients and the cross-sectional nature of the study. Future study designs on this topic may benefit from repeated VF and OCT-A measurements. In addition, this study was applied only to MS patients who had ON attacks. Evaluation of cases who did not have ON attacks may provide more detailed information on the subject and help us understand whether the findings are related to MS disease or ON attacks.

CONCLUSION

This study showed that the decrease in retinal vascular parameters in MS patients with ON attacks may be correlated with the deterioration in MD and PSD values in the visual field output. Combining structural and functional tests may be useful in clinical studies of MS patients. Vascular parameters can be used as a fast and simple method to estimate visual functions in MS patients who have difficulty in performing VA and who cannot cooperate.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Kahramanmaraş Sütçü İmam University Faculty of Medicine Ethics Committee (Date: 27.08.2024, Decision No: 210).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Katz Sand I. Classification, diagnosis, and differential diagnosis of multiple sclerosis. *Curr Opin Neurol*. 2015;28(3):193-205.
2. Britze J, Frederiksen JL. Optical coherence tomography in multiple sclerosis. *Eye (London, England)*. 2018;32(5):884-888. doi:10.1038/s41433-017-0010-2
3. Lanzillo R, Cennamo G, Criscuolo C, et al. Optical coherence tomography angiography retinal vascular network assessment in multiple sclerosis. *Multiple Sclerosis*. 2018;24(13):1706-1714. doi:10.1177/1352458517729463
4. Naumovska M, Sheikh R, Bengtsson B, Malmsjö M, Hammar B. Visual outcome is similar in optic neuritis patients treated with oral and i.v. high-dose methylprednisolone: a retrospective study on 56 patients. *BMC Neurology*. 2018;18(1):160. doi:10.1186/s12883-018-1165-6
5. Petzold A, Fraser CL, Abegg M, et al. Diagnosis and classification of optic neuritis. *Lancet Neurol*. 2022;21(12):1120-1134. doi:10.1016/s1474-4422(22)00200-9
6. Trip SA, Schlottmann PG, Jones SJ, et al. Optic nerve atrophy and retinal nerve fibre layer thinning following optic neuritis: evidence that axonal loss is a substrate of MRI-detected atrophy. *Neuroimage*. 2006;31(1):286-293. doi:10.1016/j.neuroimage.2005.11.051
7. Cheng H, Laron M, Schiffman JS, Tang RA, Frishman LJ. The relationship between visual field and retinal nerve fiber layer measurements in patients with multiple sclerosis. *Invest Ophthalmol Vis Sci*. 2007;48(12):5798-5805.
8. Khalil DH, Said MM, Abdelhakim MASE, Labeeb DM. OCT and visual field changes as useful markers for follow-up of axonal loss in multiple sclerosis in Egyptian patients. *Ocul Immunol Inflamm*. 2017;25(3):315-322.
9. Cennamo G, Romano MR, Vecchio EC, et al. Anatomical and functional retinal changes in multiple sclerosis. *Eye*. 2016;30(3):456-462. doi:10.1038/eye.2015.256
10. Plumb J, McQuaid S, Mirakhur M, Kirk J. Abnormal endothelial tight junctions in active lesions and normal-appearing white matter in multiple sclerosis. *Brain Pathol*. 2002;12(2):154-169. doi:10.1111/j.1750-3639.2002.tb00430.x
11. Wang X, Jia Y, Spain R, et al. Optical coherence tomography angiography of optic nerve head and parafovea in multiple sclerosis. *Br J Ophthalmol*. 2014;98(10):1368-1373. doi:10.1136/bjophthalmol-2013-304547
12. Ulusoy MO, Horasanlı B, Işık Ulusoy S. Optical coherence tomography angiography findings of multiple sclerosis with or without optic neuritis. *Neurol Res*. 2020;42(4):319-326. doi:10.1080/01616412.2020.1726585
13. Farci R, Carta A, Cocco E, Frau J, Fossarello M, Diaz G. Optical coherence tomography angiography in multiple sclerosis: a cross-sectional study. *PLoS One*. 2020;15(7):e0236090. doi:10.1371/journal.pone.0236090
14. Mohammadi S, Gouravani M, Salehi MA, et al. Optical coherence tomography angiography measurements in multiple sclerosis: a systematic review and meta-analysis. *J Neuroinflammation*. 2023;20(1):85. doi:10.1186/s12974-023-02763-4
15. Caprio M, Russo C, Giugliano A, Ragucci M, Mancini M. Vascular disease in patients with multiple sclerosis: a review. *J Vasc Med Surg*. 2016;4(2):746-753.
16. Akarsu C, Tan FU, Kendi T. Color Doppler imaging in optic neuritis with multiple sclerosis. *Graefes Arch Clin Exp Ophthalmol*. 2004;242(12):990-994. doi:10.1007/s00417-004-0948-1

Archives of
Ophtalmological Research

Original Article

DOI: 10.51271/AOR-0019

The effect of phacoemulsification on the intraocular pressure, anterior chamber and pupildiameter in patients with pseudoexfoliation syndrome

Tevfik Oğurel, Gülsun Solmaz, Erdem Dursun

Department of Ophtalmology, Faculty of Medicine, Kırıkkale University, Kırıkkale, Turkiye

Received: 31/08/2024 ◆ **Accepted**: 05/10/2024 ◆ **Published**: 23/10/2024

Cite this article: Oğurel T, Solmaz G, Dursun E. The effect of phacoemulsification on the intraocular pressure, anterior chamber and pupildiameter in patients with pseudoexfoliation syndrome. *Arch Ophthalmol Res*. 2024;1(4):69-71.

Corresponding Author: Tevfik Oğurel, ogureltevfik@hotmail.com

ABSTRACT

Aims: To evaluate the effect of phacoemulsification on the intraocular pressure, anterior chamber and pupil diameter in patients with pseudoexfoliation syndrome.

Methods: 66 eyes of thirty-three patients who had pseudoexfoliation (PEX) and underwent phacoemulsification enrolled in this retrospective study. The eyes divided two groups as a study group that with pseudoexfoliation syndrome (PES) or PEX glaucoma and the other eyes as a control group without PES or PEX glaucoma. The follow-up examinations were preoperatively and postoperatively on the first day, fourth day, first month, and three months. It is important to note that PES often affects the other eye as well. Studies using electromicroscopic, histochemical, and immunohistochemical methods have detected exfoliation material in the other eye, meaning it cannot be considered completely healthy. Best-corrected visual acuity (BCVA), intraocular pressure (IOP), anterior chamber depth (ACD) and pupil diameter (PD) were evaluated at each visit, and glaucoma medications were noted.

Results: There was no statistically significant difference when compared preoperative and postoperative IOP values on the first day between two groups ($p>0.05$). The mean IOP postoperatively at 4th, 30th day and 3rd months, reduced according to preoperative values in the study group ($p<0.05$). Mean anterior chamber depth and pupil diameter were increased significantly at the final visit ($p<0.001$).

Conclusion: Cataract surgery has a beneficial effect on patients with PEX including IOP, ACD and PD.

Keywords: PEX, IOP, ACD, PD

INTRODUCTION

Pseudoexfoliation syndrome (PES) is an age-related condition characterized by the accumulation of fibrogranular extracellular flake-shaped material with a gray appearance in the anterior segment of the eye and visceral organs.[1,2] Previous studies have shown the etiological association between cataract and PES.[3] The shallower anterior chamber and grade of cataract are higher in patients with PES.[4,5] PES is the most common cause of secondary open-angle glaucoma due to fibro-granular material deposition in the outflow pathway of the trabecular meshwork. The level of intraocular pressure (IOP) is the most important indicator to decide on treatment in glaucoma patients. Cataract surgery in patients with pseudoexfoliation (PEX) glaucoma has a positive effect in lowering IOP.[6] Also, Anterior chamber depth (ACD) and pupil diameter (PD) are smaller that complicate the cataract surgery in patients with PEX. PEX material can be removed from the eye with cataract surgery. Therefore PD, ACD may change after cataract surgery in patients with PEX. In this study, we evaluated IOP and anterior segment parameters include PD, ACD of glaucomatous and non- glaucomatous patients with PEX after phacoemulsification and intraocular lens implantation.

METHODS

The study was carried out with the permission of the Kırıkkale University Faculty of Medicine Ethics Committee (Date: 05.06.2024, Decision No: 2024.05.02). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Sixty-six eyes of thirty-three patients with routine cataract surgeries and no postoperative complications that were operated at Kırıkkale University Faculty of Medicine were included in this retrospective study. All patient files were

reviewed retrospectively. Only the patients who underwent bilateral cataract surgery had PES, or PEX glaucoma in one eye and the other eye normal were included.

Exclusion criteria were a history of refractive surgery, patients with phacodonesis or zonular weakness, history of glaucoma surgery or laser trabeculoplasty. PES was diagnosed under biomicroscopic examination. PEX materials were visualized on the anterior lens surface, iris, iridocorneal angle or pupillary border. Patients with PEX glaucoma diagnosed by visual field defects and/or glaucomatous optic nerve changes. All surgeries were performed with phacoemulsification, and intraocular lens implantation with hydroimplantaion technique under topical anesthesia by the same surgeon (OT) and the quick-chop phacoemulsification technique was performed. In both groups, two side-ports and a main temporal incision were performed in all eyes. Following injection of viscoelastic 2% hydroxypropyl methylcellulose (Eyevisc, Biotech, India) in both group continuous curvilinear capsulorhexis, hydrodissection, phacoemulsification of the nucleus and cortex aspiration were performed. In group 1, no viscoelastic was injected in the eye. Then the irrigation cannula introduced into the anterior chamber through left side port with irrigation on. After the tip of the cartridge was put into the main port in the direction of the capsular bag, IOL (Eyecryl plus, Biotech, India) was gradually injected. The aspiration cannula was inserted through the other side port, and the optic and haptic were placed into the capsular bag through pressing lightly on by bimanual cannula. Finally, all corneal incisions were hydrated. Posterior capsule rupture or zonular dialysis did not occur in any eyes. The eyes divided two groups as a study group that with PES or PEX glaucoma and the other eyes as a control group without PES or PEX glaucoma. The follow-up examinations were preoperatively and postoperatively on the first day, fourth day, first month, and three months. Best-corrected visual acuity (BCVA), IOP, ACD, and PD were evaluated at each visit, and glaucoma medications were noted. It is important to note that PES often affects the other eye as well. Studies using electromicroscopic, histochemical, and immunohistochemical methods have detected exfoliation material in the other eye, meaning it cannot be considered completely healthy.[7]

BCVA was measured by Snellen chart. IOP was measured with Goldmann applanation tonometry. ACD and PD were measured with optical biometer (Al-Scan, Nidek, Japan) The data for the patients analyzed using SPSS (version 20.0 IBM). Q-q plots were examined, histogram and Shapiro-Wilk's test were used to assess the data normality. For categorical variables, the chi-square test and numerical variables, a parametric paired sample test was used. A p value less than 0.05 was considered significant

RESULTS

There were 18 (%54.4) women and 15 (%45.6) men with a mean age 69.80±6.72 years in the study. In the study group, 20 eyes had PEX and 13 eyes had PEX glaucoma that used at least an antiglaucomatous drug. The mean preoperative IOP was 17.82±3.14 in group 1 and 15.61±2.79 in group 2. There was no statistically significant difference when compared preoperative and postoperative IOP values on the first day between two groups (p>0.05). The mean IOP postoperatively at 4th, 30th day and 3rd months were 16.00±3.13, 15.97±2.73 and 15.48±2.53 respectively. The mean postoperative IOP except first postoperative day significantly reduced according to preoperative values in the study group (p<0.05). The mean IOP values of the two groups are shown in Table 1. Mean anterior chamber depth was 3.11±0.41 before the cataract surgery. After phacoemulsification and IOL implantation, the ACD increased significantly to 4.08±0.48 (p<0.001, Table 2). Mean PD before and after the surgery were 4.08±0.52 and 4.87±0.67. Mean pupil diameter was increased significantly at the final visit (p<0.001, Table 2). Glaucoma medication recruitment was reduced in patients with PEX glaucoma. Five patients had passed to monotherapy from the fixed combination.

Table 1. Intraocular pressure in the groups before and after phacoemulsification

	Preop	Postop	Postop 4. day	Postop	Postop	p value
Group 1	17.82±3.14	17.18±2.86	16.00±3.13	15.97±2.73	15.48±2.53	0.165a
						0.013b
						0.006c
						0.001d
Group 2	15.61±2.79	16.39±3.30	15.18±3.52	15.03±2.55	14.52±2.98	0.281a
						0.582b
						0.426c
						0.114d

a: Comparison preop-postop 1. day, b: preop-postop 4. day, c: preop-postop 30. day, d: preop-postop 3. month

Table 2. The changes of ACD and PD of patients with pseudoexfoliation

	Preop	Postop 3. month	p value
ACD	3.11±0.41	4.08±0.48	<0.001
PD	4.08±0.52	4.87±0.67	<0.001

ACD: Anterior chamber depth; PD: Pupil diameter

DISCUSSION

This study presented that cataract surgery reduces IOP values in the long term. Also, the rate of antiglaucoma treatment or the number of antiglaucoma agents was reduced after the surgery.

All patients had deeper an anterior chamber when compared with the other eye and before the surgery. The pupil diameter increased after the surgery. PEX is characterized by production and deposition of abnormal fibrillar extracellular material in the ocular adnexa, Iris and Lens Capsule. Due to its manifestation, zonular weakness, Iris atrophy, and the non-dilating pupil may It is important to note that PES often affects the other eye as well. Studies using electromicroscopic, histochemical, and immunohistochemical methods have detected exfoliation material in the other eye, meaning it cannot be considered completely healthy occur in patients. Also, the anterior chamber depth is smaller.[8,9] Doganay et al.[10] evaluated anterior segment parameters in patients with (PEX) syndrome or (PEX) glaucoma and found that ACD was significantly lower in the PEX glaucoma group that 80 eyes of 57 patients compared with 80 eyes of 45 healthy subjects. In the other study, Güngör SG et al.[11] compared ACD in patients with PES who underwent phacoemulsification and found that ACD values increased following the surgery. In our study, ACD values were more extensive in both patients with PES

and PEX glaucoma after cataract surgery than preoperative values. Small pupil size is the most frequent trouble in PES that related to surgical complication.[12] There are many studies reported smaller pupil diameter in PES despite the mydriatic medication.[13-15] In this study, the authors compared pupil diameter with healthy control, but in our study, we analyzed the difference before and after the surgery, and we found a higher pupil size. We think that this result may be related with the cleaning of the fibrogranuler material from the surface of the lens and iris margin which forcing the pupil dilatation. Cataract and glaucoma often coexist in eyes with glaucoma and PES.[16] There some reports are stating that cataract extraction has positive effects on intraocular pressure. Lai et al.[16] evaluated outcomes of 21 patients who had cataract and primary angle closure glaucoma following cataract surgery. They found IOP decreased significantly when compared with intraoperative level. The requirement for the anti-glaucomatous drug was reduced from 1.91±0.77 (range, 1-3) to 0.52±0.87 (range, 0-3) at the last visit.[17] Especially this effect is more pronounced in PES and PEX glaucoma. Lia et al. All compared the effect of phacoemulsification in two types glaucoma that primary open angle and PEX. In this study, the IOP level reduced significantly after the surgery for both kinds. In the other research that comprised 1122 eyes with PES, the author found a long-term reduction in IOP in patients who 2.7% progressed to the need for glaucoma treatment almost three years after phacoemulsification. There is no consensus on why IOP reduce after cataract surgery. The outflow of aqueous humor may simplify because of the trabecular meshwork cleaned especially in patients with PEX.[18]

Limitations

In our study, all parameters which we evaluated in this study showed that phacoemulsification or cataract surgery has a beneficial effect in patients with PEX. The other advantage of cataract surgery is that increasing the anterior chamber depth reduces the risk of primary angle closer glaucoma attack. Also, due to the pupil relaxes, pupil size increases and the response to light returns to normal. The limitation of this study was the small sample size.

CONCLUSION

This study showed that the benefit of cataract surgery does not only improve the vision but also reduces IOP, increases ACD and PD in patients with PEX. Furthermore, recruitment of glaucoma medication was reduced following the cataract surgery. It is more accurate to perform cataract surgery before deciding on glaucoma surgery in these patients.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Kırıkkale University Faculty of Medicine Ethics Committee (Date: 05.06.2024, Decision No: 2024.05.02).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Ritch R, Schlötzer-Schrehardt U. Exfoliation syndrome. *Surv Ophthalmol*. 2001;45(4):265-315.
2. Ritch R. Exfoliation syndrome: what we know now. *Glaucoma Topics Trends*. 2006;4:1-4.
3. Schlötzer-Schrehardt U, Naumann GO. Ocular and systemic pseudoexfoliation syndrome. *Am J Ophthalmol*. 2006;141(5):921-937.
4. Shingleton BJ, Neo YN, Cvintal V, Shaikh AM, Liberman P, O'Donoghue MW. Outcome of phacoemulsification and intraocular lens implantion in eyes with pseudoexfoliation and weak zonules. *Acta Ophthalmol*. 2017;95(2):182-187.
5. Tarkkanen AH, Kivelä TT. Comparison of primary open-angle glaucoma and exfoliation glaucoma at diagnosis. *Eur J Ophthalmol*. 2015;25(2):137-139.
6. Dosso AA, Bonvin ER, Leuenberger PM. Exfoliation syndrome and phacoemulsification. *J Cataract Refract Surg*. 1997;23(1):122-125.
7. Öncel B, Pınarcı E, Akova Y. Psödoeksfoliyasyon syndrome. *Turk Klin J Ophthalmol*. 2011;20(2):99-107).
8. Nathan N, Kuchtey RW. Genetics, diagnosis, and monitoring of pseudoexfoliation glaucoma. *Curr Ophthalmol Rep*. 2016:4(4):206-212.
9. Erkayhan GE, Dogan S. Cataract surgery and possible complications in patients with pseudoexfoliation syndrome. *Eurasian J Med*. 2017;49(1): 22-25.
10. Doganay S, Tasar A, Cankaya C, Firat PG, Yologlu S. Evaluation of pentacam-scheimpflug imaging of anterior segment parameters in patients with pseudoexfoliation syndrome and pseudoexfoliative glaucoma. *Clin Exp Optom*. 2012;95(2):218-222.
11. Gür Güngör S, Akman A, Asena L, Aksoy M, Sarıgül Sezenöz A. Changes in anterior chamber depth after phacoemulsification in pseudoexfoliative eyes and their effect on accuracy of intraocular lens power calculation. *Turk J Ophthalmol*. 2016;46(6):255-258.
12. Philip SS, John SS, Simha AR, Jasper S, Braganza AD. Ocular clinical profile of patients with pseudoexfoliation syndrome in a tertiary eye care center in South India. *Middle East Afr J Ophthalmol*. 2012;19(2): 231-236.
13. Drolsum L, Haaskjold E, Sandvig K. Phacoemulsification in eyes with pseudoexfoliation. *J Cataract Refract Surg*. 1998;24(6):787-792.
14. Shastri L, Vasavada A. Phacoemulsification in Indian eyes with pseudoexfoliation syndrome. *J Cataract Refract Surg*. 2001;27(10):1629-1637.
15. Fine IH, Hoffman RS. Phacoemulsification in the presence of pseudoexfoliation: challenges and options. *J Cataract Refract Surg*. 1997;23(2):160-165.
16. Lai JS, Tham CC, Chan JC. The clinical outcomes of cataract extraction by phacoemulsification in eyes with primary angle-closure glaucoma (PACG) and co-existing cataract: a prospective case series. *J Glaucoma*. 2006;15(1):47-52.
17. Shingleton BJ, Laul A, Nagao K, et al. Effect of phacoemulsification on intraocular pressure in eyes with pseudoexfoliation: single-surgeon series. *J Cataract Refract Surg*. 2008;34(11):1834-1841.
18. Jacobi PC, Krieglstein GK. Trabecular aspiration: a new surgical approach to improve trabecular facility in pseudoexfoliation glaucoma. *Int Ophthalmol*. 1994;18(3):153-157.

Archives of
Ophtalmological Research

Original Article

DOI: 10.51271/AOR-0020

Short-term results of steroid treatment in patients with non-arteritic ischemic optic neuropathy

Melek Kaya, Şerife Gülhan Konuk, Raşit Kılıç

Department of Ophthalmology, Faculty of Medicine, Tokat Gaziosmanpaşa University, Tokat, Turkiye

Received: 15/09/2024 ◆ Accepted: 17/10/2024 ◆ Published: 23/10/2024

Cite this article: Kaya M, Konuk ŞG, Kılıç R. Short-term results of steroid treatment in patients with non-arteritic ischemic optic neuropathy. *Arch Ophthalmol Res.* 2024;1(4):72-74.

Corresponding Author: Melek Kaya, melek5806kaya@gmail.com

ABSTRACT

Aims: To evaluate the effects of steroid treatment on the best-corrected visual acuity (BCVA) and retinal nerve fiber layer (RNFL) in patients with non-arteritic ischemic optic neuropathy (NAION).

Methods: The retrospective study included 24 eyes of 24 patients who received 1 gram/day pulse steroid treatment for 3 days with a diagnosis of NAION. The patients' comorbidities, demographic information, intraocular pressure, BCVA, and RNFL measured by optical coherence tomography (OCT) were recorded before and after treatment at one month.

Results: The mean age of the patients was 64.35±14.6 (22-86). Diabetes mellitus was present in 14 patients (58.3%), hypertension in 13 (54.2%), and coronary artery disease in 5 (27.8%). The pre-treatment BCVA was 0.33±0.37, and post-treatment BCVA was 0.37±0.36 (p=0.365). The pre-treatment RNFL value was 208.0±57.9 µm, and post-treatment RNFL value was 113.6±32.6 µm (p<0.001). No additional complications related to treatment were observed.

Conclusion: While there was no significant difference in BCVA values at one month after steroid treatment, a significant anatomical improvement was observed in RNFL thickness.

Keywords: Non-arteritic ischemic optic neuropathy, pulse steroid, retinal nerve fiber layer

INTRODUCTION

Non-arteritic ischemic optic neuropathy (NAION) is a type of optic neuropathy characterized by sudden and painless unilateral loss of altudinal vision due to decreased blood flow to the optic nerve head.[1] Although NAION usually occurs in patients aged 50-70 years, approximately 10% of patients who develop NAION are younger than 50 years.[2]

Hypoperfusion and ischemia of the posterior ciliary arteries (PCA) are implicated in the development of NAION. The most commonly accepted view of ischemia is that transient hypoperfusion and nonperfusion occur without thromboembolic events. Another accepted, but less common, view is that ischemia may be caused by rare embolic occlusion of the arteries and arterioles that supply the optic nerve head.[3] Histopathological examination of the optic nerve reveals degeneration of the myelin sheath, axonal edema, axonal degeneration, and infarcts at the level of the lamina cribrosa.

Systemic diseases such as nocturnal hypotension, diabetes mellitus, hypertension, atherosclerosis, hypercholesterolemia, and obstructive sleep apnea syndrome are the most commonly blamed predisposing factors. In addition, small physiologic cup in the optic disc or lack of cup/disc area, small optic disc and vascular branching anomalies are other important predisposing factors for NAION.[4-7]

There is no treatment protocol for NAION whose efficacy has been fully recorded. Although there are various studies in the literature, the main aim of treatment is to reduce the edema of the optic disc head in the early period, to prevent stasis in the earliest period and thus to reduce the effect of ischemia. With the edema reducing and anti-inflammatory mechanism of action of steroids, NAION can be used for therapeutic purposes.[8]

In our study, we aimed to investigate the short-term effects of steroid use on retinal nerve fiber layer (RNFL) thickness and best corrected visual acuity (BCVA) in patients with NAION.

METHODS

The study was conducted in accordance with the ethical standards of the Declaration of Helsinki and approved by the Tokat Gaziosmanpaşa University Ethics Committee (Date: 06.06.2024, Decision No: 24-KAEK-186). Twenty-four eyes of 24 patients who were diagnosed with NAION between January 2021 and July 2023 in the Department of Ophthalmology, Tokat Gaziosmanpaşa University Hospital were retrospectively analyzed.

Patients who presented to the clinic with complaints of sudden visual loss and were diagnosed with NAION with relative afferent pupillary defect, optic disc edema and peripapillary flame-shaped hemorrhage, subitudinal and/or central visual field defect and were treated with 1 g/day pulse steroid for 3 days were included in the study. Patients were given antacidic drugs to reduce the side effects of steroids on the stomach. Blood glucose levels of the patients were monitored regularly. Blood pressure was monitored frequently because steroids may cause blood pressure elevation. Demographic data and systemic diseases were recorded at the first visit and one month after treatment, BCVA was measured using the Snellen chart, detailed ophthalmological examinations were performed, and intraocular pressure (IOP) measurements were recorded. RNLF measurements with spectral-domain optical coherence tomography (OCT) (Zeiss Cirrus HD-OCT 5000) were also recorded.

Patients with temporal arteritis, collagen tissue diseases, diabetic retinopathy, hypertensive retinopathy, optic neuritis, uveitis, and systemic drug use toxic to the optic nerve or retina were excluded.

SPSS 22.0 (IBM Corp., USA) program was used for the analyses. Distributional characteristics of the data were determined by Shapiro-Wilk's test. Normally distributed quantitative data were expressed as mean±standard deviation and categorical data were expressed as percentage (%). Dependent samples t-test was used to compare normally distributed quantitative data. A p-value less than 0.05 was considered statistically significant.

RESULTS

The study included 24 eyes of 24 patients. Of these, 12 (50%) were male and 12 (50%) were female.The mean age of the patients was 64.35±14.6 (22-86). Diabetes mellitus was detected in 14 patients (58.3%), hypertension in 13 (54.2%), and coronary artery disease in 5 (27.8%) (Table 1). The pre-treatment intraocular pressure was 15.3±3.2 mmHg, and post-treatment intraocular pressure was 15.44±2.8 mmHg (p=0.85). The pre-treatment BCVA was 0.33±0.37, and post-treatment BCVA was 0.37±0.36 (p=0.365). The pre-treatment RNFL value was 208.0±57.9 µm, and post-treatment RNFL value was 113.6±32.6 µm (p<0.001) (Table 2). No complications were observed post-treatment.

Table 1. Demographic characteristics of patients

Number of patients	**24**
Gender male (%), female (%)	12(50%)/12(50%)
Eye right (%), left (%)	14(58.3%)/10(41.7%)
Average age (distribution)	64.35±14.6 (22-86)
Additional diseases: DM (%), hypertension (%), coronary artery disease (%)	14(58.3%)/13(54.2%)/5(27.8%)

DM: Diabetes mellitus

DISCUSSION

Table 2. BCVA and RNFL values

	Before treatment	**After treatment**	**p value**
Best corrected visual acuity (Snellen Chart)	0.33±0.37	0.37±0.36	p=0.365
RNFL µm	208.0±57.9	113.6±32.6	p<0.001*

BCVA: Best corrected visual acuity, RNLF: Retinal nerve fiber layer

Visual acuity in NAION, which is characterized by sudden visual impairment, varies in a wide range from mild visual blurring to severe visual loss. In our study, the mean visual acuity of the patients was 0.33±0.37.

Although NAION is rarely reported to be seen in younger patients, it is typically reported to be seen over the age of 50 years10. In our study, the mean age of the patients was 64.35±14.6 (22-86), which is similar to the literature.

Many authors have stated that the pathogenesis of NAION is multifactorial. It has been suggested that it may be related to systemic disorders, such as nocturnal hypotension, diabetes, hypertension, and arteriosclerosis, which reduce the autoregulatory capacity of the optic disc. NAION is thought to result from transient hypoperfusion of the optic nerve head. Despite the varying prevalence of predisposing factors across different studies, systemic conditions such as diabetes, hypertension and coronary artery disease have been frequently reported in patients.[2-6] In our study, consistent with the literature, 58.3% of patients had diabetes mellitus, 54.2% had hypertension, and 27.8% had coronary artery disease, indicating a high prevalence of these predisposing factors.

There is no classical treatment for NAION with proven efficacy. When the literature is reviewed, various medical and surgical treatment options have been tried in NAION, but there is no clear opinion on their effectiveness. When we look at the treatment protocols, antiaggregant and thrombolytic agents to prevent the development of NAION in the other eye, neuroprotective agents and hyperbaric oxygen therapy for axonal protection and minimization of myelin loss, intravitreal anti vascular endothelial growth factor inhibitors (VEGF) to reduce disc edema, systemic and intravitreal steoid use have been reported.[10-13]

Steroid therapy is one of the most commonly used treatment options. The use of systemic corticosteroids as a treatment option for NAION began in the 1960s and 1970s, following several case series that showed improvement in visual outcomes in NAION patients treated with steroids.[8] The goal of steroid treatment is to increase blood flow to the optic nerve head by reducing edema and relieving compression of the capillaries, due to its anti-inflammatory and edema-reducing effects.[14] However, when we look at the studies, the effectiveness of steroids shows variability across different research.

In a study conducted by Hayreh et al.[13] on 613 patients diagnosed with NAION, the group given 80 mg/day prednisone treatment in the acute phase of the disease, i.e. in the first 2 weeks, was compared with the control group. In this study, it was reported that regression of disc edema was observed in 6.8 weeks in patients treated with systemic steroid therapy, whereas it was observed in 8.2 weeks in the control group. Visual acuity improved in 69.8% of the patients in the systemic steroid group, while this rate was 40.5% in the control group. As a result, it was reported that visual acuity, visual field improvement and optic disc edema improved more quickly.

In another case report, in a case of acute NAION with subretinal fluid and dense edema of the optic disc head, an increase in visual acuity and a decrease in disc edema with dense edema of the optic disc head were reported after high

dose (1 g/day) methylprednisolone administration for 3 days.[15]

In contrast to these studies, Rebolleda et al.[16] applied 80 mg/day systemic corticosteroid treatment in patients with acute NAION and found that steroid treatment was not effective in terms of visual acuity and anatomical improvement. In addition, they reported steroid-related complications in 3 patients, and therefore, it was reported that steroid did not have a beneficial effect in NAION in this study. Authors have emphasized that steroid treatment should be administered with careful consideration of the risk-benefit ratio and side effect profile for each individual patient.

In our study, while anatomical improvement was found in the thickness of the nerve fiber layer, we found no difference in BCVA.

Limitations

The limitations of our study include the short follow-up period and the small sample size. Additionally, the absence of a control group affects the quality of the study in determining the true efficacy of steroid treatment.

CONCLUSION

In conclusion, it was observed that steroid treatment did not significantly improve visual acuity in patients; however, it significantly improved the resolution of optic disc edema.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Tokat Gaziosmanpaşa University Ethics Committee (Date: 06.06.2024, Decision No: 24-KAEK-186)

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Espino Barros A, Amram AL, Derham AM, Smith SV, Lee AG. Management of ischemic optic neuropathies. *Exp Rev Ophthalmol.* 2017;12(2):99-109.
2. Hattenhauer MG, Leavitt JA, Hodge DO, Grill R, Gray DT. Incidence of nonarteritic anterior ischemic optic neuropathy. *Am J Ophthalmol.* 1997;123(1):103-107. doi:10.1016/s0002-9394(14)70999-7
3. Reis AS, Sharpe GP, Yang H, Nicolela MT, Burgoyne CF, Chauhan BC. Optic disc margin anatomy in patients with glaucoma and normal controls with spectral domain optical coherence tomography. *Ophthalmology.* 2012;119(4):738-747. doi:10.1016/j.ophtha.2011.09.054
4. Lee MS, Grossman D, Arnold AC, Sloan FA. Incidence of nonarteritic anterior ischemic optic neuropathy: increased risk among diabetic patients. *Ophthalmology.* 2011;118(5):959-963. doi:10.1016/j.ophtha.2011.01.054
5. Hayreh SS, Joos KM, Podhajsky PA, Long CR. Systemic diseases associated with nonarteritic anterior ischemic optic neuropathy. *Am J Ophthalmol.* 1994;118(6):766-780. doi:10.1016/s0002-9394(14)72557-7
6. Hayreh SS, Zimmerman MB, Podhajsky P, Alward WL. Nonarteritic anterior ischemic optic neuropathy: role of nocturnal arterial hypotension. *Arch Ophthalmol.* 1997;115(7):942-945. doi:10.1001/archopht.1997.01100160112031
7. Wu Y, Zhou LM, Lou H, Cheng JW, Wei RL. The association between obstructive sleep apnea and nonarteritic anterior ischemic optic neuropathy: a systematic review and meta-analysis. *Curr Eye Res.* 2016;41(7):987-992. doi:10.3109/02713683.2015.1075221
8. Al-Zubidi N, Zhang J, Spitze A, Lee AG. Systemic corticosteroids in nonarteritic ischemic optic neuropathy. *Indian J Ophthalmol.* 2014;62(10):1022-1024. doi:10.4103/0301-4738.146015
9. Mathews MK. Nonarteritic anterior ischemic optic neuropathy. *Curr Opin Ophthalmol.* 2005;16(6):341-345. doi:10.1097/01.icu.0000188361.52166.93
10. Schönfeld CL, Fischer M, Distelmaier P, et al. Recovery of visual function after administration of dabigatran etexilate. *Case Rep Ophthalmol.* 2014;5(2):262-266. doi:10.1159/000365961
11. Danylkova NO, Alcala SR, Pomeranz HD, McLoon LK. Neuroprotective effects of brimonidine treatment in a rodent model of ischemic optic neuropathy. *Exp Eye Res.* 2007;84(2):293-301. doi:10.1016/j.exer.2006.10.002
12. Prescott CR, Sklar CA, Lesser RL, Adelman RA. Is intravitreal bevacizumab an effective treatment option for nonarteritic anterior ischemic optic neuropathy?. *J Neuroophthalmol.* 2012;32(1):51-53. doi:10.1097/WNO.0b013e318240596e
13. Hayreh SS, Zimmerman MB. Non-arteritic anterior ischemic optic neuropathy: role of systemic corticosteroid therapy. *Graefes Arch Clin Exp Ophthalmol.* 2008;246(7):1029-1046. doi:10.1007/s00417-008-0805-8
14. Hayreh SS. Management of ischemic optic neuropathies. *Indian J Ophthalmol.* 2011;59(2):123-136. doi:10.4103/0301-4738.77024
15. Takayama K, Kaneko H, Kachi S, Ra E, Ito Y, Terasaki H. High-dose intravenous pulse steroid therapy for optic disc swelling and subretinal fluid in non-arteritic anterior ischemic optic neuropathy. *Nagoya J Med Sci.* 2017;79(1):103-108. doi:10.18999/nagjms.79.1.103
16. Rebolleda G, Pérez-López M, Casas-LLera P, Contreras I, Muñoz-Negrete FJ. Visual and anatomical outcomes of non-arteritic anterior ischemic optic neuropathy with high-dose systemic corticosteroids. *Graefes Arch Clin Exp Ophthalmol.* 2013;251(1):255-260. doi:10.1007/s00417-012-1995-7

Archives of
Ophtalmological Research

Original Article

DOI: 10.51271/AOR-0021

Vision-related quality of life in low-vision patients who underwent epiretinal membrane surgery

Fatih Horozoğlu[1], Hidayet Şener[1], Osman Ahmet Polat[1], Özkan Sever[2], Turgut Yüksel[3], Cem Evereklioğlu[1]

[1]Department of Ophthalmology, Faculty of Medicine, Erciyes University, Kayseri, Turkiye
[2]Department of Ophthalmology, Silivri Kolan Hospital, İstanbul, Turkiye
[3]Department of Ophthalmology, Beylikdüzü Kolan Hospital, İstanbul, Turkiye

Received: 02/10/2024 ◆ Accepted: 18/10/2024 ◆ Published: 23/10/2024

Cite this article: Horozoğlu F, Şener H, Polat OA, Sever Ö, Yüksel T, Evereklioğlu C. Vision-related quality of life in low-vision patients who underwent epiretinal membrane surgery. *Arch Ophthalmol Res*. 2024;1(4):75-78.

Corresponding Author: Fatih Horozoğlu, fhoroz@yahoo.com

ABSTRACT

Aims: To evaluate the vision-related quality of life (VR-QOL) in patients with low vision, who underwent epiretinal membrane (ERM) surgery with pars plana vitrectomy.

Methods: Twenty subjects with unilateral ERM and 20 healthy subjects as control group (CG) were included in the study. The National Eye Institute Visual Function Questionnaire-25 (NEI VFQ-25) was used. In ERM cases, the two-step 23 G vitrectomy was performed with a similar technique by the same experienced vitreoretinal surgeon. The relationship between the composite score and visual acuity was evaluated. Reliability analysis was performed. Flexible discriminant analysis was performed to group individuals according to the NEI VFQ-25 results.

Results: The preoperative best corrected visual acuity (BCVA) in ERM group was 1.04±0.41. Postoperative visual improvement reached statistical significance ($p<0.001$) and postoperative 6th month BCVA was 0.61±0.41. The composite score was significantly lower in patients with ERM than in CG ($p=0.017$). The subscale scores were significantly lower in the patients with ERM than in the CG in general vision, ocular pain, near activities and distance activities ($p<0.001$, $p=0.005$, $p<0.001$, $p=0.003$, respectively). There was a statistically significant correlation between the composite score and visual acuity ($R^2=0.19$, $p=0.004$). The scale has high reliability (Cronbach's alpha=0.8743). The accuracy of the flexible discriminant function was found to be 100%.

Conclusion: The NEI VFQ-25 questionnaire may help to define the effects of ERM surgery since visual acuity does not fully reflect VR-QOL. Impaired binocular vision may be associated with the deterioration of VR-QOL in patients with ERM in the postoperative period.

Keywords: ERM, epiretinal membrane, NEI VFQ-25, vision-related quality of life, VR-QOL

INTORDUCTION

Vision-related quality of life (VR-QOL) is a measure of the impact of visual impairment on daily activities and quality of life.[1] Recently, VR-QOL assessment has included the use of tools such as the National Eye Institute Visual Function Questionnaire (NEI VFQ-25).[2,3] The 25-item NEI-VFQ-25 is preferred for evaluating the outcome of treatment of various eye diseases including cataract, keratoconus, glaucoma, age related macular degeneration, macular hole, epiretinal membrane (ERM), central serous chorioretinopathy, diabetic retinopathy, retinal vein occlusion and retinal detachment.[4-6]

Functional assessment and health-related quality of life questionnaires are becoming commonplace to measure the impact of ophthalmic treatments on patients' ability to perform their visual functions. Recent studies have reported a correlation between NEI-VFQ-25 scores and visual acuity, and a beneficial effect on VR-QOL with removal of ERM.[7,8] However, patients undergoing ERM surgery in these studies had relatively good preoperative visual acuity (0.50 logMAR or 6/24 Snellen). In this retrospective study, we evaluated vision-related quality of life (VR-QOL) in patients with preoperative low vision who had epiretinal membrane (ERM), and compared the results with the control group (CG). We aim to accurately characterize visual function with self-reported dimensions in patients who underwent ERM surgery.

METHODS

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Namık Kemal University Non-interventional Clinical Researches Ethics Committee (Date: 28.09.2017, Decision No: 2017/80/08/04) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

In this retrospective and nonrandomized clinical trial, we evaluated 20 patients (20 eyes) who underwent 23 gauge transconjunctival pars plana vitrectomy (PPV) with internal limiting membrane peeling and air tamponade to treat ERM. Twenty age-sex matched healthy individuals as CG were included in the study.

Surgical Procedures

In ERM cases, a two-stage 23 G vitrectomy (Stellaris PC; Bausch and Lomb, Rochester, NY, USA) was performed with a similar technique by the same experienced vitreoretinal surgeon (FH) under local anesthesia. The standard surgical procedure was core vitrectomy, removal of the ERM and internal limiting membrane, fluid-air exchange. The patients were placed in the face-down position for 1 postoperative day.

Patients

Patients with unilateral idiopathic ERM who were treated with PPV and had no intraoperative complications were included in the study. Twenty age-sex-matched healthy individuals without retinal disease (diabetic retinopathy, retinal vein occlusion, etc) and glaucoma were included in the study. Patients with proliferative vitreoretinopathy, intraocular hemorrhage, amblyopia, high refractive error, severe cataract, glaucoma, vitreoretinal disorders and any intraocular surgery other than cataract surgery were excluded from the study. The best corrected visual acuities (BCVA) of the patients were evaluated before the operation, in the first month, third month, and sixth month postoperatively. BCVA was evaluated using a Snellen chart and converted to the logarithm of the minimum angle of resolution (logMAR) units.

The 25-Item National Eye Institute Visual Function Questionnaire

The VR-QOL was assessed by the NEI VFQ-25. Patients answered the Turkish version of the NEI VFQ-25.[3] This questionnaire contains questions related to their general health status and 11 questions about visual perceptions of patients, including general vision, ocular pain, near activities, distance activities, social functioning, mental health, role limitations, dependency, driving, color vision and peripheral vision. Each item in the survey is scored from 0 to 100. The average score of 11 of the subscales is taken to obtain the composite score. According to the instructions of Mangione et al.,[2] the general health subscale is not included in the NEI VFQ-25 composite score.

Statistical Analysis

All statistical analyses were performed using with NCSS version 12 (Utah, USA) and R Studio version 4 (Vienna, Austria). The Shaphiro-Wilk normality test was performed with the data set. The pearson chi-square test was used for nominal ordinal data. The visual acuity of the ERM group was compared with the repeated measurement ANOVA test. Visual acuity and NEI VFQ-25 results of the CG and ERM group were compared with the Mann-Whitney U test. The relationship between the composite NEI VFQ-25 score and visual acuity was evaluated by simple linear regression. Reliability analysis was performed. Flexible discriminant analysis was performed to group individuals according to the NEI VFQ-25 results. Missing data were available in the driving category in patient with ERM. In the discriminant analysis, the missing data in the driving category was corrected according to the mean and the analysis was performed. Data were expressed as mean±standard deviation. The significance levels were set at $p<0.05$.

RESULTS

The average age was 67.6±5.9 years in ERM group and 64.4±5.1 years in CG. There were no statistical difference ($p>0.05$) between the groups in terms of age and sex. The demographic characteristics of the groups are presented in Table 1. The mean preoperative BCVA in the ERM group was 1.04±0.41. Postoperative visual improvement reached statistical significance ($p<0.001$) and postoperative 6th month BCVA was 0.61±0.41. The change in postoperative visual acuity in patients with ERM is presented in Table 2 and Figure 1. The postoperative 6th month BCVA was significantly lower in ERM patients than in CG ($p<0.001$). The visual acuity comparison is presented in Table 3.

Table 1. Demographic characteristics of groups

	Control (20)	Epiretinal membrane (20)	p
Age	64.4±5.1	67.6±5.9	0.080
Sex	8M/12F	9M/11F	0.749

Student t test, pearson Chi-square test, significance level is p<0.05, M: Male, F: Female

Table 2. Visual acuity change after epiretinal membrane surgery

	Mean±SD	p
Preoperative BCVA	1.04±0.41	<0.001
Postoperative BCVA 1th month	0.73±0.43	<0.001
Postoperative BCVA 3th month	0.63±0.40	<0.001
Postoperative BCVA 6th month	0.61±0.41	<0.001

Repeated Measurements ANOVA test, significance level is p<0.05, SD: Standard deviation, BCVA: Best corrected visual acuity

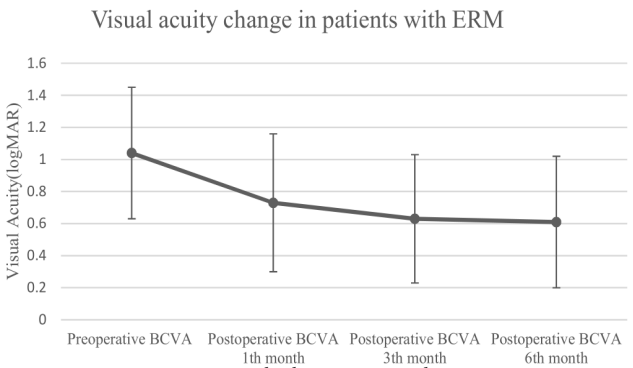

Figure 1. Postoperative 6-month change in visual acuity in ERM patients (with means and standard deviations)

ERM: Epiretinal membrane, BCVA: Best corrected visual acuity

Table 3 Visual acuity comparison of ERM postoperative 6th month and CG

BCVA	Mean±SD		p
Control vs ERM (vitrectomized eye)	0.02±0.02	0.61±0.41	<0.001
Control vs ERM (nonvitrectomized eye)	0.02±0.02	0.05±0.05	0.751
ERM (vitrectomized eye vs non vitrectomized eye)	0.61±0.41	0.05±0.05	<0.001

Mann-Whitney U test, significance level is p<0.05, CG: Control group, BCVA: Best corrected visual acuity, SD: Standard deviation, ERM: Epiretinal membrane

A comparison of the NEI VFQ-25 questionnaire in the 6th month postoperatively is presented in Table 4. The composite score was significantly lower in patients with ERM than in the CG (p=0.017). The general vision, ocular pain, near activities and distance activities scores were significantly lower in the ERM patients than in the CG (p<0.001, p=0.005, p<0.001, p=0.003, respectively). There was a statistically significant correlation between the composite NEI VFQ-25 score and visual acuity (R^2=0.19, p=0.004).

Table 4. Comparison of NEI VFQ-25 between groups

	Control (20)	Epiretinal membrane (20)	p
General health	50.00±22.94	40.00±24.87	0.221
General vision	80.00±0.00	59.00±15.18	<0.001
Ocular pain	85.00±9.60	66.25±22.25	0.005
Near activities	85.00±6.59	63.31±19.00	<0.001
Distance activities	85.00±10.03	67.70±21.54	0.003
Social functioning	95.00±6.28	83.33±22.38	0.108
Mental health	78.70±17.01	71.56±23.48	0.461
Role difficulties	65.00±18.85	61.25±21.42	0.758
Dependency	93.40±6.48	91.24±21.04	0.201
Driving	78.60±9.79	54.12±36.98	0.241
Color vision	88.75±17.16	90.00±12.57	0.968
Peripheral vision	65.00±23.51	75.00±22.94	0.242
Composite score	83.22±8.49	71.95±17.90	0.017

Mann-Whitney U test, significance level is p<0.05

The scale has high reliability (Cronbach's alpha=0.8743). The Cronbach's alpha coefficient ranged from 0.880 to 0.846 for the subscales. It was found that our data did not meet the multivariate normality assumption (Mardia's Kurtosis test p<0.001 and Mardia's Skewness test p<0.001).The accuracy of the flexible discriminant function was found to be 100%. The 11 variables (except general health status) included in the analysis were expressed with 1 canonical variate. The distribution of the groups according to the canonical variate is presented in Figure 2.

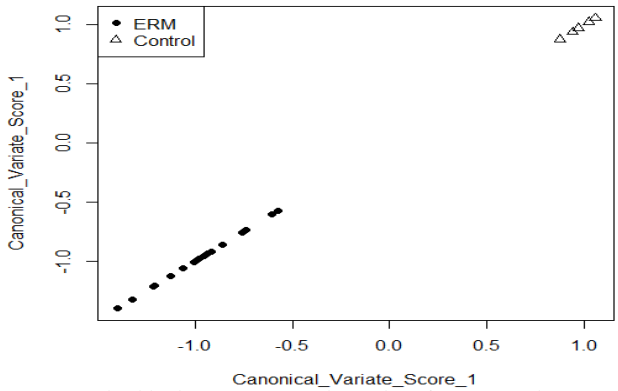

Figure 2. Flexible discriminant analysis plot of a canonical variate score expressing 11 variable of the NEI VFQ-25

ERM: Epiretinal membrane, NEI VFQ-25: National Eye Institute Visual Function Questionnaire

DICUSSION

In the present study, we saw that apart from increased visual acuity there was a lower quality of life with the self-reported dimensions. The reliability of the NEI VFQ-25 questionnaire was evaluated and was found to accurately measure VR-QOL. The NEI-VFQ 25 questionnaire was found to be able to discriminate between the ERM group and the CG.

Successful ERM surgery often results in positive visual outcomes.[9,10] There was a significant increase in visual acuity at 6 month follow up, however visual acuity may be insufficient to express many aspects of visual function and to predict whether individuals experience difficulties in real-world activities.[11] Our results confirm this information and visual acuity explained 19% of the composite score of NEI VFQ-25. More importantly metamorphopsia after ERM surgery may be permanent[7,12] and decrease vision-related quality of life.[8] In our results, the composite score of patients with ERM remained lower than the CG. Additionally, unilateral ERM may impair stereopsis and cause metamorphopsia as an independent condition, and surgery might contribute positively to improving these visual disturbances.

Binocular interference was defined as a condition in which the quality of vision was worse with both eyes open compared with one eye closed. It was reported in a recent study that binocular interference worsens the quality of life of patients with ERM.[13] ERM is usually unilateral or asymmetrically bilateral.[14] The visual performance of the patients' fellow eyes were generally unaffected. Thus, although the composite score of patients with unilateral ERM was lower than CG, patients with ERM were found to be similar to CG in other categories except for general vision, ocular pain, and near and far activity categories. Uneven vision levels after surgery may cause binocular interference and result in lower subscale categories compared to CG. However, the point to be considered when evaluating these results is that we conducted the NEI-VFQ 25 questionnaire at the 6th month postoperatively. After ERM surgery, visual improvement has been reported in 43% of eyes at 12 month, 54% at two year, and 60% at 3 year,[15] and this may lead to an improvement in NEI-VFQ 25 results in the long term.

In previous studies evaluating the postoperative NEI VFQ-25 results of ERM patients, mean NEI VFQ-25 composite score are as follows, respectively; 77.9,[8] 78.5[4]. The mean composite scores of NEI VFQ-25 after vitreoretinal surgery in patients with macular hole, rhegmatogenous retinal detachment, proliferative diabetic retinopathy, and age-related macular degeration have been reported as 82.4,[16] 80.3,[17] 68.5[18] and 54.4[19] respectively. In the present study, the mean composite score of NEI VFQ-25 was 71.9 and was lower than the ERM patients reported in the literature and was similar to the score of patients with proliferative diabetic retinopathy (PDR). It should be noted that the composite score was better in diseases that usually affect only one side, such as ERM, macular hole and rhegmatogenous retinal detachment, than in diseases that usually affect both sides, such as PDR and age-related macular degeneration.

Ghazi-Nouri et al.[7] reported a significant association between binocular BCVA and VR-QOL, but no association with VR-QOL for monocular BCVA, metamorphopsia, and contrast sensitivity in ERM patients. Metamorphopsia in age-

related macular degeneration[20] and vitreomacular traction[21] has been reported to be associated with VR-QOL. Another study reported that stereopsis was consistently altered in patients with ERM and was associated with VR-QOL.[22]

Limitations

The limitation of our study is that we did not evaluate the preoperative NEI VFQ-25 score and did not evaluate the metamorphopsia and steropsis of the patients. However, this study represents the first evaluation of NEI VFQ-25 outcomes following ERM surgery in the Turkish population, highlighting its unique contribution to the field.

CONCLUSION

This is the first paper reporting NEI VFQ-25 after ERM surgery in a Turkish population. In present study, we demonstrated that near and distance activity scores and ocular pain scores were worse in ERM patients. We demonstrated that the NEI VFQ-25 questionnaire may help to define the effects of ERM surgery on visual quality since the visual acuity does not exactly reflect VR-QOL. In conclusion, findings such as metamorphopsia and impaired stereopsis can persist in the postoperative period in patients with ERM and can impair VR-QOL.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Namık Kemal University Non-interventional Clinical Researches Ethics Committee (Date: 28.09.2017, Decision No: 2017/80/08/04).

Informed Consent

Informed consent was obtained from all individual participants included in the study.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Elliott DB, Pesudovs K, Mallinson T. Vision-related quality of life. *Optom Vis Sci.* 2007;84(8):656-658.
2. Mangione CM, Lee PP, Gutierrez PR, et al. Development of the 25-list-item national eye institute visual function questionnaire. *Arch Ophthalmol.* 2001;119(7):1050-1058.
3. Toprak AB, Eser E, Guler C, Baser FE, Mayali H. Cross-validation of the Turkish version of the 25-item national eye institute visual functioning questionnaire (NEI-VFQ 25). *Ophthalmic Epidemiol.* 2005; 12(4):259-269.
4. Okamoto F, Okamoto Y, Fukuda S, Hiraoka T, Oshika T. Vision-related quality of life and visual function after vitrectomy for various vitreoretinal disorders. *Inves Ophthalmol Vis Sci.* 2010;51(2):744-751.
5. Aydin Kurna S, Altun A, Gencaga T, Akkaya S, Sengor T. Vision related quality of life in patients with keratoconus. *J Ophthalmol.* 2014; 2014:694542.
6. Lina G, Xuemin Q, Qinmei W, Lijun S. Vision-related quality of life, metamorphopsia, and stereopsis after successful surgery for rhegmatogenous retinal detachment. *Eye.* 2016;30(1):40-45.
7. Ghazi-Nouri SM, Tranos PG, Rubin GS, Adams ZC, Charteris DG. Visual function and quality of life following vitrectomy and epiretinal membrane peel surgery. *Br J Ophthalmol.* 2006;90(5):559-562.
8. Okamoto F, Okamoto Y, Hiraoka T, Oshika T. Effect of vitrectomy for epiretinal membrane on visual function and vision-related quality of life. *Am J Ophthalmol.* 2009; 147(5):869-874.
9. Margherio RR, Cox Jr MS, Trese MT, Murphy PL, Johnson J, Minor LA. Removal of epimacular membranes. *Ophthalmology.* 1985;92(8):1075-1083.
10. Grewing R, Mester U. Results of surgery for epiretinal membranes and their recurrences. *Br J Ophthalmol.* 1996;80(4):323-326.
11. Owsley C, Sloane ME. Contrast sensitivity, acuity, and the perception of'real-world'targets. *Br J Ophthalmol.* 1987;71(10):791-796.
12. Bouwens MD, Van Meurs JC. Sine amsler charts: a new method for the follow-up of metamorphopsia in patients undergoing macular pucker surgery. *Graefes Arch Clin Exp Ophthalmol.* 2003;241(2):89-93.
13. Hatt SR, Leske DA, Iezzi R, Holmes JM. Binocular interference vs diplopia in patients with epiretinal membrane. *JAMA Ophthalmol.* 2020;138(11):1121-1127.
14. Fung AT, Galvin J, Tran T. Epiretinal membrane: a review. *Clin Experiment Ophthalmol.* 2021;49(3):289-308.
15. Pesin SR, Olk RJ, Grand MG, et al. Vitrectomy for premacular fibroplasia: prognostic factors, long-term follow-up, and time course of visual improvement. *Ophthalmology.* 1991;98(7):1109-1114.
16. Tranos PG, Ghazi-Nouri SM, Rubin GS, Adams ZC, Charteris DG. Visual function and subjective perception of visual ability after macular hole surgery. *Am J Ophthalmol.* 2004;138(6):995-1002.
17. Okamoto F, Okamoto Y, Hiraoka T, Oshika T. Vision-related quality of life and visual function after retinal detachment surgery. *Am J Ophthalmol.* 2008;146(1):85-90.
18. Okamoto F, Okamoto Y, Fukuda S, Hiraoka T, Oshika T. Vision-related quality of life and visual function following vitrectomy for proliferative diabetic retinopathy. *Am J Ophthalmol.* 2008;145(6):1031-1036.
19. Cahill MT, Stinnett SS, Banks AD, Freedman SF, Toth CA. Quality of life after macular translocation with 360° peripheral retinectomy for age-related macular degeneration. *Ophthalmology.* 2005;112(1):144-151.
20. Xu K, Gupta V, Bae S, Sharma S. Metamorphopsia and vision-related quality of life among patients with age-related macular degeneration. *Can J Ophthalmol.* 2018;53(2):168-172.
21. Patel PJ, Steel DH, Hirneiß C, Brazier J, Aly A, Lescrauwaet B. Patient-reported prevalence of metamorphopsia and predictors of vision-related quality of life in vitreomacular traction: a prospective, multi-centre study. *Eye.* 2019;33(3):435-444.
22. Khanna RK, Pichard T, Pasco J, et al. Monocular and binocular visual parameters associated to vision-related quality of life in patients with epiretinal membrane: a prospective cohort. *Graefe's Arch Clin Exp Ophthalmol.* 2021;259:1723-1730.