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Subfoveal Choroidal Thickness Before and After Intravitreal Ranibizumab Injection in Patients With Choroidal Neovascularization

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Abstract

Background: Ranibizumab is an antivascular endothelial growth factor agent made for intraocular use as a smaller antibody fragment that can penetrate the retina. Intravitreal ranibizumab therapy has been accepted as a predominant treatment for choroidal neovascularization (CNV) in recent years.

Objective: The aim was to assess the potential adverse effects of ranibizumab on the choroid, variations in choroidal thickness were measured before and after ranibizumab treatment for CNV.

Patients and methods: This prospective research study was carried out at the Ophthalmology Department of Al-Azhar University Hospitals on 20 patients from June 2021 till December 2021 to monitor changes of choroidal thickness before and after ranibizumab treatment for CNV to assess possible adverse effects of ranibizumab on the choroid.

Results: There were highly statistically significant variations between before injection and after injection regarding choroidal thickness. The mean \pm SD choroidal thickness before injection was 356.85 ± 127.10 SD, with range from 154.0 to 632.0, and the mean \pm SD choroidal thickness after injection was 235.40 ± 75.60 SD, with range from 127.0 to 400.0. There was a highly statistically significant variation between before injection and after injection regarding central macular thickness (CMT). The mean \pm SD CMT before injection was 302.80 ± 84.51 , with range from 168 to 490, and the mean \pm SD CMT after injection was 250.25 ± 53.44 , with range from 150 to 331.

Conclusion: Patients with CNV had a subfoveal choroidal thickness that was noticeably thicker in the affected eyes than in nonaffected contralateral eyes. SubFoveal Choroidal Thickness (SFCT) declined substantially after intravitreal ranibizumab administration, and this was associated with marginal reduction in retinal foveal thickness.

Keywords: Choroidal neovascularization, Intravitreal ranibizumab, Subfoveal choroidal thickness

1. Introduction

Choroidal neovascularization (CNV) can develop quickly in people with Bruch's membrane defects, which affect choroid's innermost layer. It is also related to great levels of vascular endothelial growth factor (VEGF). CNV can happen regularly with rare genetic disease pseudoxanthoma elasticum and rarely with more common optic disc drusen, in addition to wet macular degeneration.¹

CNV has also been linked to severe myopia and malignant myopic degeneration, in which CNV usually arises in the presence of lacquer cracks

within retinal macular tissue. CNV can complicate virtually any pathologic process that involves retinal pigment epithelium and damages Bruch's membrane.²

It is now well defined that VEGF plays a key role as an inciting stimulus involved in CNV development during the initial stage of neovascular lesion. Endothelial cell (EC), pericytes, glial cells, Müller cells, ganglion cells, photoreceptors, and Retinal Pigment Epithelium (RPE) are all potential sources of VEGF.³

Existing standard treatment for exudative age-related macular degeneration is intravitreal injections of ranibizumab, which is a Fab fragment of

recombinant, humanized, monoclonal antibody that blocks all isoforms of VEGF-A.⁴

Ranibizumab is a 48 kDa monovalent monoclonal antibody fragment that functions as an antigen-binding Fab but lacks the Fc domain. This structure was created to block FcRn binding and, as result, dramatically shorten its systemic half-life after entering systemic circulation from the eye, to around 3 h, and to enable distribution across all retinal layers to choroidal vasculature.⁵

Numerous researchers have reported on the role of choroid in the pathogenesis of many ocular diseases, such as Age Related Macular Degeneration (AMD), polypoidal choroidal vasculopathy, central serous chorioretinopathy, and myopic CNV, using improved depth imaging optical coherence tomography (EDI-OCT), which is based on spectral-domain OCT technology. Recently, it has been proposed that choroidal thinning may play a role in the development of CNV associated with AMD and high myopia.⁶

Through mechanism involving enhanced nitric oxide production, VEGF works to dilate vessels and raise ocular blood flow. Long-term VEGF inhibition by ranibizumab may then cause constriction of choroidal vessels, leading to further thinning of the choroid. Even so, there is currently only very little data on the effects of ranibizumab on the choroid.⁷

The current research sought to assess the potential adverse effect of ranibizumab on the choroid by monitoring variations in choroidal thickness before and after ranibizumab treatment for CNV.

2. Patients and methods

This prospective research study was carried out at the Ophthalmology Department of Al-Azhar University Hospitals from June till December 2021 to monitor changes of choroidal thickness before and after ranibizumab treatment for CNV to assess possible adverse effects of ranibizumab on the choroid. The research group consisted of 20 patients with CNV. We performed longitudinal measurements of choroidal thickness before and after ranibizumab treatment for CNV using OCT (Swept Source OCT DRI Triton 2016, Topcon Company, Made In Japan.) using enhanced-depth imaging techniques.

Inclusion criteria: symptomatic neovascular lesions under center of fovea and presence of active exudative features involving macula were the inclusion criteria.

Exclusion criteria: obscuration of retinal and choroidal images by media opacity (corneal opacity,

cataract, and vitreous hemorrhage) and thick subfoveal hemorrhage; presence of extrafoveal and juxta-foveal CNV; presence of other macular abnormalities (e.g. macular hole or central serous chorioretinopathy); history of previous treatment for CNV like thermal laser photocoagulation, photodynamic treatment, and intravitreal triamcinolone injection; eyes with history of pars plana vitrectomy and other intraocular surgeries; and history of cataract surgery were the exclusion criteria.

All patients were subject to the following:

All studied cases underwent complete ophthalmological test.

Full medical and ophthalmic history was taking as follows: full history taking, full ophthalmic examination, visual acuity, extraocular muscle movement, extent of proptosis, eyelid retraction, eyelid edema and hyperemia, intraocular pressure (IOP), best-corrected visual acuity (BCVA), slit-lamp test, and fundus test.

The history was taken from the patient, and symptoms were asked about regarding decreased visual acuity and metamorphopsia.

Ocular examinations included BCVA using Snellen chart and then conversion to logMAR equivalent for statistical calculation. Full slit-lamp examination of cornea, iris, and crystalline lens was done. Fundus test was done using auxiliary lens 90 D.

Investigations included the following: optical coherence tomography of macula (OCT Macula), fundus fluorescein angiography, and central foveal thickness.

Choroidal thickness was measured using OCT at the time of diagnosis and at 4 months after 3 monthly injections of ranibizumab 0.5 mg/0.050 ml as a loading dose using on-demand protocol.

2.1. Postoperative follow-up

At 30 min following intravitreal injection, tonometry was used to oversee IOP height in the cases studied. Supervision also included checking for perfusion of the optic nerve head instantly after injection. Cases were also supervised for and instructed to notify any symptoms suggestive of endophthalmitis as soon as possible after injection. Postoperative topical antibiotic was administered for 1 week.

2.2. Adverse effects and complications following intravitreal injection

Endophthalmitis, rhegmatogenous retinal detachment, and iatrogenic traumatic cataract were

among serious adverse events associated with intravitreal injections, which were found in less than 0.1% of cases. Subconjunctival hemorrhage, eye pain, vitreous floaters, and elevated IOP were the most common ocular adverse effects.

Nonocular adverse effects were as follows: nasopharyngitis, anemia, nausea, and cough.

2.3. Statistical analysis

The Statistical Package for the Social Sciences version 20 was used to analyze data (SPSS Inc., Chicago, Illinois, USA). Mean and SD were used to describe quantitative variables. Number and percentage were used to describe qualitative variables. Student's *t* examination was used to compare parametric quantitative variables among two categories. When the frequency was less than 5, qualitative variables were compared using χ^2 examination and Fisher's exact examination. Pearson correlation coefficients were calculated to determine the relationship between two normally distributed variables. To compare two periods, paired *t*-test was used for normally distributed quantitative variables. To compare two periods, Wilcoxon signed-rank experiment was used for not normally distributed quantitative variables. Comparison between differences by time for non-parametric data was done using Wilcoxon signed-rank sum test (*z*). To determine the degree of association between two sets of variables, Pearson's correlation coefficient (*r*) examination was used. Confidence interval was set at 95% and the acceptable margin of error was set at 5%. As a result, *P* value was deemed significant as follows: *P* value of less than 0.05 was considered important when the variable was not normally distributed.

3. Results

Table 1 shows that 8 (40%) studied cases were males and 12 (60%) were females. The mean \pm SD age was 59.80 ± 11.69 years, with range from 39.0 to 80.0.

Table 1. Distribution of studied cases according to demographic data (*n* = 20).

	N (%)
Sex	
Male	8.0 (40)
Female	12.0 (60)
Years old	
Minimum–maximum	39–80
Mean \pm SD	59.80 ± 11.69
Median (IQR)	61.50 (50.0–68.50)

IQR, interquartile range.

3.1. BCVA

Table 2 shows that the mean \pm SD BCVA by decimal before injection was 0.32 ± 0.14 , with range from 0.20 to 0.40, and the mean \pm SD BCVA by decimal after injection was 0.48 ± 0.21 , with range from 0.36 to 0.63.

Table 3 shows that there was a highly statistically significant variation between before injection and after injection according to BCVA by decimal. Mean \pm SD BCVA by decimal before injection was 0.32 ± 0.14 , with range from 0.20 to 0.40, and the mean \pm SD BCVA by decimal after injection was 0.54 ± 0.18 , with range from 0.40 to 0.63.

3.2. IOP

Table 4 shows that there was an insignificant variation between before injection and after injection according to IOP. The mean \pm SD IOP before injection was 17.18 ± 2.21 , with range from 12.40 to 21.0, and the mean \pm SD IOP after injection was 17.53 ± 2.39 , with range from 12.40 to 23.0.

3.3. SFCT

Table 5 shows that there was a highly statistically significant variation between before injection and after injection according to choroidal thickness. The mean \pm SD choroidal thickness before injection was 356.85 ± 127.10 , with range from 154.0 to 632.0, and the mean \pm SD choroidal thickness after injection was 235.40 ± 75.60 , with range from 127.0 to 400.0.

3.4. Central macular thickness (CMT)

Table 6 shows that there was a highly significant variation between before injection and after injection according to CMT. The mean \pm SD CMT before injection was 302.80 ± 84.51 , with range from 168 to 490, and the mean \pm SD CMT after injection was 250.25 ± 53.44 , with range from 150 to 331.

Table 7 shows a statistically significant positive correlation between BCVA by decimal chart before injection and IOP before intravitreal injection of lucentis, with *P* value of 0.028. However, a statistically significant negative correlation between BCVA by decimal chart before injection and CMT before injection, with *P* value 0.028.

There was no statistically significant correlation among BCVA by decimal chart after injection, IOP after intravitreal injection of lucentis, choroidal

Table 2. Descriptive analysis of studied cases as stated by BCVA by decimal in each period.

	N	Minimum–maximum	Mean \pm SD	Median (IQR)
BCVA by decimal				
Before injection	17 ^a	0.10–0.50	0.32 \pm 0.14	0.32 (0.20–0.40)
After injection	20	0.13–0.80	0.48 \pm 0.21	0.50 (0.36–0.63)

BCVA, best-corrected visual acuity; IQR, interquartile range.

^a Three cases are missed.

Table 3. Comparison between before injection and after injection according to BCVA by decimal ($n = 17$).

	Before injection	After injection	Z	P
BCVA by decimal				
Minimum–maximum	0.10–0.50	0.16–0.80		
Mean \pm SD	0.32 \pm 0.14	0.54 \pm 0.18	3.517*	<0.001*
Median (IQR)	0.32 (0.20–0.40)	0.50 (0.40–0.63)		
Change	\uparrow 0.22 \pm 0.13			

BCVA, best-corrected visual acuity; IQR, interquartile range; P, P value to compare between before injection and after injection; Z, Wilcoxon signed-rank examination.

*Statistically important at $P \leq 0.05$.

Table 4. Comparing among before injection and after injection as stated by IOP ($n = 20$).

	Before injection	After injection	t	P
IOP				
Minimum–maximum	12.40–21.0	12.40–23.0		
Mean \pm SD	17.18 \pm 2.21	17.53 \pm 2.39	1.139	0.269
Median (IQR)	17.30 (16.40–18.55)	17.30 (16.40–19.0)		
Change	\uparrow 0.36 \pm 1.41			

IOP, intraocular pressure; IQR, interquartile range; P, P value to compare between before injection and after injection; t, paired t-test.

*Statistically important at $P \leq 0.05$.

Table 5. Comparing among before injection and after injection as stated by choroidal thickness ($n = 20$).

	Before injection	After injection	t	P
Choroidal thickness				
Minimum–maximum	154.0–632.0	127.0–400.0		
Mean \pm SD	356.85 \pm 127.10	235.40 \pm 75.60	8.294*	<0.001*
Median (IQR)	364.0 (277.0–457.5)	207.5 (182.5–300.0)		
Change	\downarrow 121.45 \pm 65.48			

IQR, interquartile range; P, P value to compare between before injection and after injection; t, paired t-test.

*Statistically important at $P \leq 0.05$.

Table 6. Comparing between before injection and after injection as stated by central macular thickness ($n = 20$).

	Before injection	After injection	t	P
Central macular thickness				
Minimum–maximum	168–490	150–331		
Mean \pm SD	302.80 \pm 84.51	250.25 \pm 53.44	4.579	<0.001*
Median (IQR)	290 (248–355)	252 (215–304)		
Change	\downarrow 52.55 \pm 17.77			

IQR, interquartile range; P, P value to compare among before injection and after injection; t, paired t-test.

*Statistically important at $P \leq 0.05$.

thickness after injection, and CMT after injection, with P greater than 0.05 (NS) (Table 8).

There was a statistically significant negative correlation among change before and after injection according to BCVA and choroidal thickness, with P value of 0.037. However, there was a statistically significant positive correlation between change before and after injection according to

choroidal thickness and CMT, with P value of 0.042 (Table 9).

3.5. Cases

3.5.1. Case 1

Figs. 1–4 show that choroidal thickness of case 1 was 170 before injection and 127 after injection.

Table 7. Correlation between BCVA by decimal chart before injection, IOP before intravitreal injection of lucentis, choroidal thickness before injection, and central macular thickness before injection, using Pearson's correlation coefficient among the study group.

	BCVA by decimal chart before injection	IOP before intravitreal injection of lucentis	Choroidal thickness before injection	Central macular thickness before injection
BCVA by decimal chart before injection				
<i>r</i>		0.533	−0.011	−0.636
<i>P</i> value		0.028*	0.966	0.006*
IOP before intravitreal injection of lucentis				
<i>r</i>	0.533		0.268	0.100
<i>P</i> value	0.028*		0.252	0.674
Choroidal thickness before injection				
<i>r</i>	−0.011	0.268		0.301
<i>P</i> value	0.966	0.252		0.198
Central macular thickness before injection				
<i>r</i>	−0.636	0.100	0.301	
<i>P</i> value	0.006*	0.674	0.198	

BCVA, best-corrected visual acuity; HS, highly significant; IOP, intraocular pressure; *r*, Pearson's relationship coefficient; S, significant. $P > 0.05$ (NS).

* $P < 0.05$ (S).

** $P < 0.001$ (HS).

Table 8. Correlation between BCVA by decimal chart after injection, IOP after intravitreal injection of lucentis, choroidal thickness after injection, and central macular thickness after injection, using Pearson's correlation coefficient among study category.

	BCVA by decimal after	IOP after intravitreal injection of lucentis	Choroidal thickness after injection	Central macular thickness after injection
BCVA by decimal after				
<i>r</i>		0.270	−0.257	−0.170
<i>P</i> value		0.250	0.274	0.473
IOP after intravitreal injection of lucentis				
<i>r</i>	0.270		0.208	0.082
<i>P</i> value	0.250		0.379	0.733
Choroidal thickness after injection				
<i>r</i>	−0.257	0.208		0.230
<i>P</i> value	0.274	0.379		0.330
Central macular thickness after injection				
<i>r</i>	−0.170	0.082	0.230	
<i>P</i> value	0.473	0.733	0.330	

BCVA, best-corrected visual acuity; IOP, intraocular pressure; *r*, Pearson's relationship coefficient.

$P > 0.05$ (NS).

Table 9. Correlation between change before and after injection according to BCVA by decimal, IOP, choroidal thickness, and central macular thickness, using Pearson's correlation coefficient among study category.

	Change of BCVA	Change of IOP	Change of choroidal thickness	Change of central macular thickness
Change of BCVA				
<i>r</i>		−0.093	−0.443	−0.350
<i>P</i> value		0.722	0.037*	0.168
Change of IOP				
<i>r</i>	−0.093		0.079	−0.214
<i>P</i> value	0.722		0.742	0.365
Change of choroidal thickness				
<i>r</i>	−0.443	0.079		0.400
<i>P</i> value	0.037*	0.742		0.042*
Change of central macular thickness				
<i>r</i>	−0.350	−0.214	0.400	
<i>P</i> value	0.168	0.365	0.042*	

BCVA, best-corrected visual acuity; HS, highly significant; IOP, intraocular pressure; *r*, Pearson relationship coefficient; S, significant.

$P > 0.05$ (NS).

* $P < 0.05$ (S).

** $P < 0.001$ (HS).



Fig. 1. Colored photograph of case 1 choroidal neovascularization.

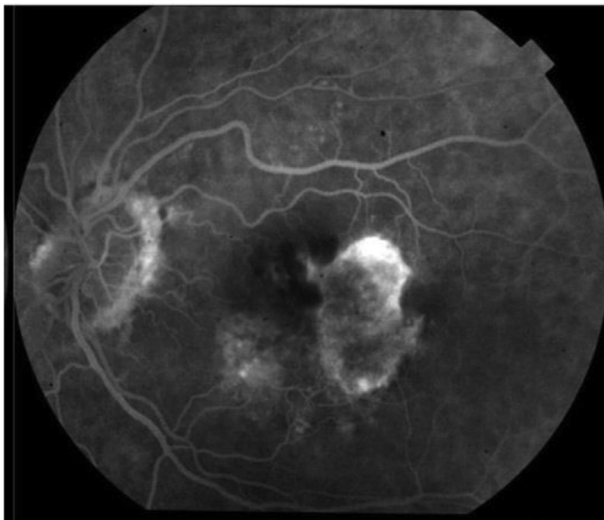


Fig. 2. Fundus Fluorescein Angiography (FFA) of case 1 choroidal neovascularization.

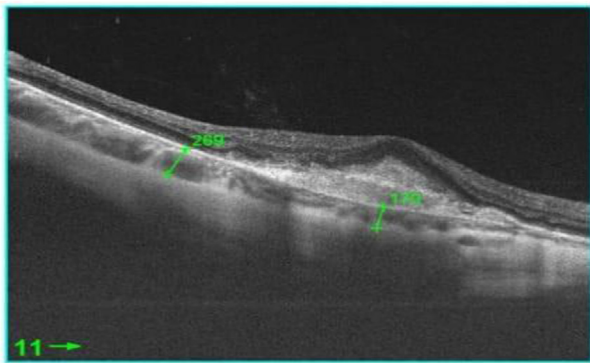


Fig. 3. Optical coherence tomography of case 1 choroidal neovascularization before injection.

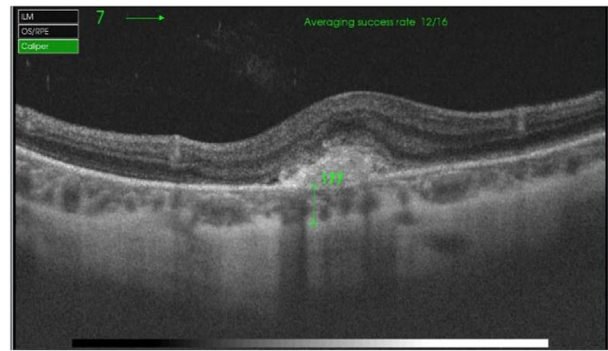


Fig. 4. Optical coherence tomography of case 1 choroidal neovascularization after injection.

3.5.2. Case 2

Figs. 5–8 show that choroidal thickness of case 2 was 171 before injection and 143 after injection.

4. Discussion

This prospective research study was conducted at Al-Azhar University Hospitals' Ophthalmology Department from June to December 2021 to reflect differences in choroidal thickness before and after ranibizumab treatment for CNV to assess the potential adverse effects of ranibizumab on the choroid. We performed longitudinal statistics of choroidal thickness before and after ranibizumab treatment for CNV using OCT (Swept Source OCT DRI Triton) using improved depth imaging techniques on 20 studied cases with CNV.

The mean \pm SD BCVA by decimal before injection was 0.55 ± 0.23 , with range from 0.30 to 1.0, and the mean \pm SD BCVA by decimal after injection was 0.37 ± 0.24 , with range from 0.10 to 0.89. The mean \pm SD BCVA by decimal before injection was 0.32 ± 0.14 , with range from 0.20 to 0.40, and the mean \pm SD BCVA by decimal after injection was 0.54 ± 0.18 , with range from 0.40 to 0.63. The mean \pm SD IOP before injection was 17.18 ± 2.21 , with range from 12.40 to 21.0, and the mean \pm SD IOP after injection was 17.53 ± 2.39 , with range from 12.40 to 23.0. The mean choroidal thickness before injection was 356.85 ± 127.10 , with range from 154.0 to 632.0, and the mean choroidal thickness after injection was 235.40 ± 75.60 , with range from 127.0 to 400.0.

Ranibizumab, a Fab fragment of humanized recombinant monoclonal antibody, inhibits all isoforms of VEGF-A. Inhibiting VEGF-A decreases leakage and further growth of CNV. Intravitreal ranibizumab injections are the current standard treatment for exudative age-related macular degeneration.⁸

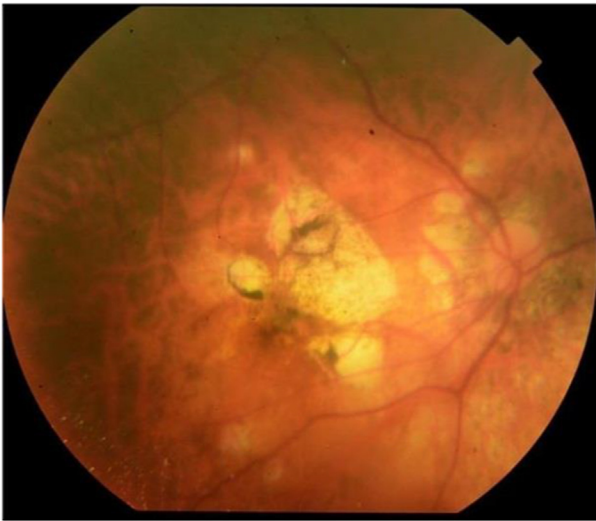


Fig. 5. Colored photograph of case 2 choroidal neovascularization.

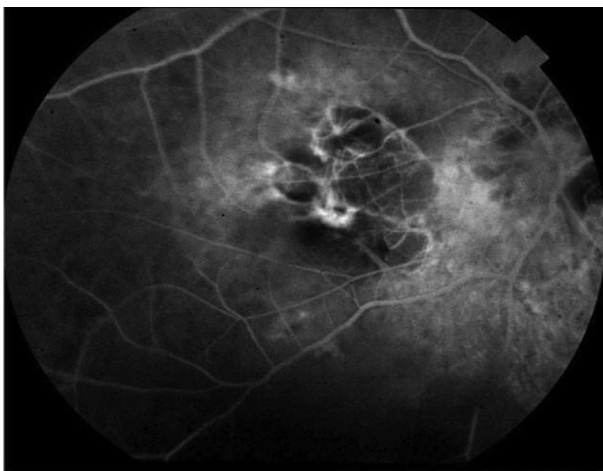


Fig. 6. FFA of case 2 choroidal neovascularization.

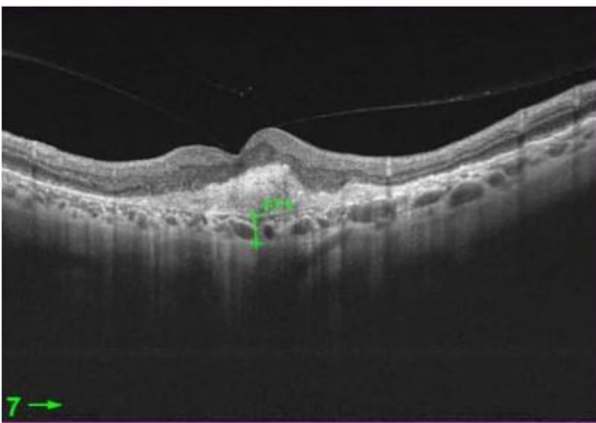


Fig. 7. Optical coherence tomography of case 2 choroidal neovascularization before injection.

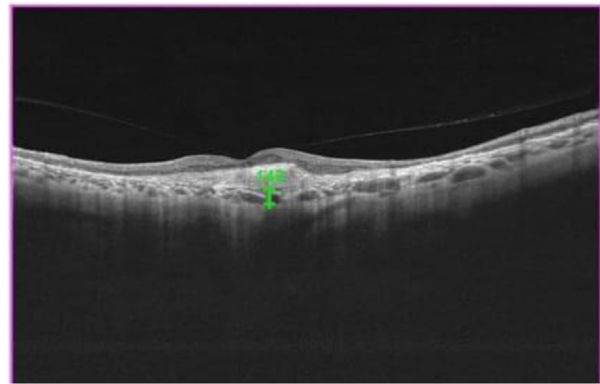


Fig. 8. Optical coherence tomography of case 2 choroidal neovascularization after injection.

Previous large-scale, prospective, randomized studies of eyes with AMD revealed that ranibizumab had a dramatic effect on CNV and improved visual acuity. Even so, to preserve initial visual advancement during loading phase (LP), most studied cases with AMD necessitate injections of ranibizumab. Retinal arteriolar diameter was discovered to have decreased by 18.5% after 30 days and 19.1% after 12 months of ranibizumab treatment for exudative AMD. As VEGF has a variety of physiological effects on eye such as cell proliferation, neuroprotection, choriocapillaris maintenance, and rises in ocular blood flow, long-term VEGF inhibition may harm the eye.⁹

In the current study, we found that 8 (40%) cases were males and 12 (60%) were females. The mean \pm SD age was 59.80 ± 11.69 years, with range from 39.0 to 80.0 years.

Saad Eldeen et al.¹⁰ found that the mean \pm SD age of studied cases was 63.3 ± 8.963 years, with range from 42 to 85 years. The studied cases included 15 (30%) males and 35 (70%) females.

In the present study, we found that mean \pm SD BCVA by decimal before injection was 0.32 ± 0.14 , with range from 0.20 to 0.40, and the mean \pm SD BCVA by decimal after injection was 0.48 ± 0.21 , with range from 0.36 to 0.63.

Cao et al.¹¹ reported that at one month after the first injection, visual acuity in the treated eyes enhanced considerably ($P < 0.001$) from 0.50 ± 0.29 logMAR (range: 0.05–1.0 logMAR) to 0.23 ± 0.21 logMAR (range: 0.08–0.7 logMAR). At the final visit, it enhanced further ($P = 0.02$) to 0.16 ± 0.17 logMAR (range: 0.00–0.52 logMAR) ($P < 0.001$ for correlation with baseline).

Our findings regarding comparison between before injection and after injection regarding BCVA by decimal revealed that there was a highly statistically significant difference between before injection

and after injection according to BCVA by decimal. The mean \pm SD BCVA by decimal before injection was 0.32 ± 0.14 , with range from 0.20 to 0.40, and the mean \pm SD BCVA by decimal after injection was 0.48 ± 0.21 , with range from 0.36 to 0.63.

Matching our results, Ellabban et al.¹² illustrated that visual acuity increased markedly one month after LP ($P = 0.005$) and at the final examination ($P < 0.001$).

Saad Eldeen et al.¹⁰ reported that the mean \pm SD preoperative BCVA on Snellen's was 0.4 ± 0.2 , whereas the mean \pm SD postoperative BVCA on Snellen's chart was 0.5 ± 0.2 , with $P = 0.001$. There were 26 cases with improved postoperative BCVA (52%), 15 cases with the same BCVA postoperative (30%), and 9 cases with worse BCVA postoperative (18%). This confirms the positive effect of ranibizumab injection on BCVA.

In our research, we found that there was an insignificant difference between before injection and after injection according to IOP. The mean \pm SD IOP before injection was 17.18 ± 2.21 , with range from 12.40 to 21.0, and the mean \pm SD IOP after injection was 17.53 ± 2.39 , with range from 12.40 to 23.0.

The present research results found a statistically significant reduction in the median CMT from 290 to a level of 252 ($P < 0.001$) after ranibizumab injection. These results agreed with the study of Ozturk et al.¹³ They also found a statistically significant decrease in the median central subfield macular thickness from 428 μm to level of 279 μm ($P < 0.001$) after bevacizumab and ranibizumab injections. The mean \pm SD CMT decreased from 471.5 ± 34.4 to 387.3 ± 87.8 in patients treated with intravitreal injection of 0.5 mg/0.1 ml ranibizumab during follow-up period in the study of Fouda and Bahgat.⁶

Recently, Daldal et al.¹⁴ found that after intravitreal ranibizumab injections, BCVA improved greatly ($P = 0.001$), whereas macular thickness lessened considerably ($P < 0.001$). There was no important relationship among changes in BCVA and CMT.

In this research, there was an important negative correlation between BCVA and CMT before injection, with $P = 0.028$. There was no important relationship between BCVA and CMT after injection ($P > 0.05$).

There was a significant positive relationship between change before and after injection regarding choroidal thickness and CMT ($P = 0.042$).

Dabir et al.¹⁵ studied the relationship of intravitreal anti-VEGF injections with BCVA, CMT, and vascular indices. CMT was independently associated with enhancement in BCVA.

After three intravitreal injections of ranibizumab, the change in CMT was clinically significant with variation in BCVA ($P < 0.001$) in the study by Sarhan et al.¹⁶

In this research, we showed that there was a highly significant difference between before injection and after injection regarding choroidal thickness. The mean \pm SD choroidal thickness before injection was 356.85 ± 127.10 , with range from 154.0 to 632.0, and the mean \pm SD choroidal thickness after injection was 235.40 ± 75.60 , with range from 127.0 to 400.0.

In agreement with our results, Yamazaki et al.¹⁷ noted that mean \pm SD subfoveal choroidal thickness reduced from 228 μm at baseline to 213 μm at 3 months ($P = 0.001$), 215 μm at 6 months ($P = 0.009$), and 213 μm at 12 months ($P = 0.015$) in eyes with exudative AMD treated with ranibizumab. Researchers noted a significant reduction in foveal choroidal thickness, but the average reduction was only 15 μm .

Ikuno et al.¹⁸ intervisit intraclass relationship coefficient for foveal choroidal thickness was found to be 0.893 (95% confidence interval: 0.864–0.916). Even so, as choroidal thickness measurement has high variance owing to focal irregularities and indistinctness of choriocleral border, it may be challenging to identify small modifications in thickness practically, even using the EDI-OCT method.

The present study results showed significant reduction in the median CMT from 290 to level of 252 ($P < 0.001$) after ranibizumab injection. These results agreed with the study of Ozturk et al.,¹³ who also found a statistically significant decrease in the median central subfield macular thickness from 428 μm to a level of 279 μm ($P < 0.001$) after bevacizumab and ranibizumab injections. The mean \pm SD CMT decreased from 471.5 ± 34.4 to 387.3 ± 87.8 in patients treated with intravitreal injection of 0.5 mg/0.1 ml ranibizumab during the follow-up period in the study of Fouda and Bahgat.⁶

Recently, Daldal et al.¹⁴ found that BCVA ($P = 0.001$) enhanced significantly and macular thickness ($P < 0.001$) reduced significantly after intravitreal ranibizumab injections. There was no significant relationship between changes in BCVA and CMT.

In our study, there was a significant negative relationship between BCVA and CMT before injection, with P value of 0.028. There was no significant relationship between BCVA and CMT after injection ($P > 0.05$).

There was a significant positive correlation between change before and after injection according to choroidal thickness and CMT ($P = 0.042$).

Dabir et al.¹⁵ studied the relationship of intravitreal anti-VEGF injections with BCVA, CMT, and vascular indices. CMT was independently associated with enhancement in BCVA.

After three intravitreal injections of ranibizumab, the change in CMT was clinically significant with variation in BCVA ($P < 0.001$) in the study by Sarhan et al.¹⁶

The 2-week CMT reduction rate after the first injection of anti-VEGF was negatively correlated with BCVA at 6 months, according to Spearman's experiment ($r = -0.359$, $P < 0.001$).¹⁹

There was no relationship among baseline SFCT and BCVA ($P = 0.670$, 0.584). There was also no relationship among variations in SFCT, BCVA, and CMT after anti-VEGF treatment ($P = 0.344$ and 0.336).⁹

Multiple regression analysis found a significant negative relationship among lower baseline SFCT and CMT and improved BCVA after 3 monthly intravitreal injections of ranibizumab LP ($P < 0.05$).²⁰

Baseline BCVA ($P < 0.001$) and CMT ($P = 0.003$) were strongly linked with final BCVA in the regression analyses, whereas SFCT or its modify was not.²¹

5. Conclusion

Patients with CNV had a subfoveal choroidal thickness that was noticeably thicker in the affected eyes than in nonaffected contralateral eyes. SFCT reduced significantly after intravitreal ranibizumab administration, and this was associated with marginal reduction in retinal foveal thickness. It was unclear if choroidal thinning was a direct pharmacological effect of ranibizumab and secondary effect of foveal retina thinning and closure of neovascular membranes. Given significant variations in SFCT at baseline between affected and nonaffected contralateral eyes, as well as a significant reduction in SFCT shortly after treatment, this research may serve as a pilot research to evaluate the role of SFCT as an extramarker for diagnosis and follow-up of CNV and potentially other neovascular maculopathies.

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Conflicts of interest

None declared.

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