

Evaluation of Macular and Optic Disc Radial Peripapillary Vessel Density with Optical Coherence Tomography Angiography in Cases with Iron Deficiency Anemia

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Abstract:

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Background: Iron deficiency anemia (IDA), the most common form of anemia, may contribute to retinal microvascular alterations. Aim and objectives: To evaluate retinal vascular density (VD) in IDA patients using optical coherence tomography angiography (OCTA), before and after 3 months of iron therapy. **Subjects and methods:** This cross-sectional case-control study was conducted at the Ophthalmology Department, Benha University Hospital, from Nov 2022 to Oct 2023 that included two groups. Group A (study group): 24 eyes from cases with IDA, examined by OCTA before and after 3 months of treatment. Group B (control group): 24 eyes from healthy individuals. **Results:** At baseline, SCP VD was significantly reduced ($P < 0.05$) in most macular regions in IDA cases, except at the fovea and nasal perifovea ($P > 0.05$). DCP VD showed no significant difference in most regions ($P > 0.05$). RPC VD was significantly reduced ($P < 0.05$) in all areas except inside the disc was not significantly different ($P > 0.05$). Following 3 months of treatment, there was a significant increase ($P < 0.001$) in Hb, MCV, serum iron, and ferritin, and significant decrease in TIBC. SCP VD significantly improved ($P < 0.05$) in all regions except the fovea ($P > 0.05$). DCP VD showed significant recovery in most areas ($P < 0.05$). **Conclusion:** Retinal microvascular changes in IDA, including reductions in SCP, DCP, and RPC, appear to be reversible following iron treatment. OCTA may serve as a valuable tool in detecting early retinal ischemia prior to clinical retinopathy in IDA cases. **Keywords:** Evaluation, macular and optic disc, radial peripapillary vessel density, optical coherence, tomography angiography, iron deficiency anemia.

Introduction

Iron deficiency anemia (IDA) is the most prevalent type of anemia worldwide, particularly affecting women of reproductive age. Iron plays a critical role in neuronal development and maintenance, including normal myelination and the structural integrity of the optic nerve.^[1] Anemia results in tissue hypoxia, which can induce neuronal damage through various mechanisms. Retinal ganglion cells (RGCs) are especially vulnerable to hypoxia due to impaired perfusion and decreased oxygen saturation^[2].

Optical coherence tomography angiography (OCTA) is a non-invasive imaging modality that enables detailed assessment of retinal vascular density (VD) without the use of intravenous contrast agents, offering a valuable tool in detecting early microvascular retinal changes.

Subjects and Methods:

This observational, cross-sectional case-control study was conducted at Benha University Hospital, involving cases referred from the Department of Internal Medicine to the Department of Ophthalmology. The study spanned from Nov 2022 to Oct 2023. Cases were divided into two groups: Group A (study group) included 24 eyes from cases diagnosed with IDA, examined using OCTA both before and after 3 months of treatment (treatments), while Group B (control group) consisted of 24 eyes from healthy individuals.

Sample size: The sample size was determined using G*Power software v3.1.9.2 based on effect size calculations from a previous study by Koca and colleagues (2022), which evaluated macular and radial peripapillary capillary (RPC) VD in IDA using OCTA. Using a Wilcoxon-Mann-Whitney test, an effect size of 0.2765, α error of 0.05, and power (1- β) of 0.23, the total required sample

size was calculated to be 48 eyes (24 per group).

Study population:

Inclusion criteria were: Hb ≤ 11.5 g/dL in females or ≤ 13.5 g/dL in males, MCV < 20 fL, serum ferritin < 20 μ g/L, serum iron < 20 μ g/dL, and TIBC > 450 μ g/dL, with age ranging from 15–40 years and inclusion of both sexes. **Exclusion criteria** included prior ocular surgery or trauma, corneal pathologies, retinal diseases (e.g., dystrophies, degenerations), refractive errors $> \pm 6.0$ D, strabismus, glaucoma, or neurological disorders.

Methods

Each participant underwent detailed medical and ophthalmologic evaluation, including history taking (age, sex, duration of anemia, visual complaints), and a complete ocular exam. Visual acuity was assessed using a Landolt chart and converted to logMAR for analysis. Anterior segment examination was performed using a slit lamp (Nidik Technologies, Japan), while posterior segment evaluation employed slit lamp biomicroscopy with a Volk +90D lens. Intraocular pressure (IOP) was measured using a Goldmann applanation tonometer. Laboratory investigations included CBC, serum ferritin, serum iron, and TIBC. OCTA imaging was conducted to evaluate macular and peripapillary microvasculature. A 6×6 mm scan centered on the fovea was used for macular VD, and a 4.5×4.5 mm scan centered on the optic disc was used for assessing RPC and RNFL thickness. OCTA segmentation parameters followed standard device defaults: SCP (from ILM to 9 μ m above IPL), DCP (9 μ m above IPL to 9 μ m below OPL), outer retina (9 μ m below OPL to 9 μ m above BRM), and choriocapillaris (9 μ m above to 30 μ m below BRM).

Ethical consideration: Ethical approval was obtained from the Research Ethics Committee, Faculty of Medicine, Benha

University (code number: MS 12-11-2022). All participants provided written informed consent after a clear explanation of the study's objectives, methodology, and confidentiality protocols. Institutional permission was granted to conduct the study at Benha University Hospitals.

Data management and statistical analysis:

Data were analyzed using SPSS software (v26, IBM Inc.). Quantitative variables were expressed as mean $\pm$ SD and range, while qualitative data were presented as frequency and percentage. Appropriate statistical tests were applied based on data type and distribution. A $P < 0.05$ was considered statistically significant, while $P < 0.001$ was regarded as highly significant. $P > 0.05$ were interpreted as non-significant.

Results

Regarding SCP VD, values were exhibited to be significantly lower in IDA cases compared to controls across all macular regions, including the whole retina, sup-hemi, inf-hemi, parafoveal (whole, sup-hemi, inf-hemi, temporal, superior, nasal, inferior) and perifoveal (whole, sup-hemi, inf-hemi, temporal, superior, inferior) ($P < 0.05$). However, the differences in the fovea and nasal perifovea were non-significant ($P > 0.05$), though both trended toward significance. (Table 1)

In the comparison of DCP VD between IDA cases and controls, no statistically significant differences were exhibited in the whole retina, sup-hemi, inf-hemi, fovea, parafoveal (sup-hemi, inf-hemi, nasal), and perifoveal (whole, sup-hemi, temporal, superior, nasal) regions ($P > 0.05$). Nonetheless, mean VD values in all these regions were slightly lower among IDA cases, apart from the fovea, where the mean was marginally higher in cases than in controls. Conversely, statistically significant reductions in VD were noted among IDA cases in the parafoveal whole,

temporal, superior, inferior sectors and the perifoveal inf-hemi and inferior regions ($P < 0.05$), indicating localized perfusion compromise in these areas. (Table 2)

Regarding RPC VD, significant reductions were exhibited in IDA cases compared to controls in the whole image, peripapillary, sup-hemi, and inf-hemi regions ($P < 0.05$), indicating compromised perfusion in these optic disc sectors. In contrast, the difference in RPC VD inside the disc was non-significant ($P > 0$). (Table 3)

Following 3 months of treatment, SCP VD demonstrated a statistically significant increase ($P < 0.05$) across multiple regions, including the whole retina, sup-hemi, inf-hemi, parafoveal (whole, sup-hemi, inf-hemi, temporal, superior, nasal, inferior) and perifoveal (whole, sup-hemi, inf-hemi, temporal, superior, nasal, inferior) in IDA cases. However, the foveal SCP VD showed a non-significant change ($P > 0.05$), indicating relative stability in that region post-treatment. (Table 4)

After 3 months of treatment, DCP VD showed a statistically significant increase ($P < 0.05$) in the whole retina, sup-hemi, inf-hemi, fovea, parafoveal (whole, sup-hemi, inf-hemi, temporal, superior, nasal, inferior) and perifoveal (whole, sup-hemi, inf-hemi, temporal, superior) among IDA cases. In contrast, changes in the perifoveal nasal and perifoveal inferior regions were non-significant ($P > 0.05$), though a slight increase was noted post-treatment in both areas (Table 5).

Following 3 months of treatment, RPC VD demonstrated a significant increase ($P < 0.05$) in the inside disc, peripapillary, sup-hemi, and inf-hemi regions among IDA cases. However, the change in RPC VD of the whole image was non-significant ($P > 0.05$), although a slight increase was exhibited post-treatment. (Table 6)

Table (1) Vessel density SCP flow (%) between studied groups:

Vessel density SCP flow (%)		Cases (n=24 eyes)	Control (n=24 eyes)	P
Whole retina		47.6±2.8	51.8±3.2	<0.001*
Superior hemi		47.8±2.9	52±3.1	<0.001*
Inferior hemi		47.4±2.8	51.6±3.4	<0.001*
Fovea		20.07±6.1	16.7±5.7	0.06
Parafovea	Parafovea whole	50.7±2.9	55.27±3.06	<0.001*
	Superior hemi	51.05±3.2	55.1±2.8	0.001*
	Inferior hemi	50.4±3.3	55.44±3.5	<0.001*
	Temporal	50.39±4.1	55.8±2.9	<0.001*
	Superior	51.5±3.2	56.3±3.2	<0.001*
	Nasal	48.6±3.1	54.5±3.8	<0.001*
	Inferior	50.6±2.9	55.9±2.5	<0.001*
Perifovea	Perifovea whole	48.22±2.3	52.1±3.6	0.002*
	Superior hemi	48.87±2.4	52.99±3.4	0.001*
	Inferior hemi	48.15±2.3	51.1±3.6	0.006*
	Temporal	45.09±3.01	49.6±3.8	<0.001*
	Superior	48.9±2.1	51.3±4.4	0.02*
	Nasal	53±2.3	54.6±4.2	0.09
	Inferior	48.1±2.6	53.6±3.4	<0.001*

* significant at P <0.05

Table (2) Vessel density DCP flow (%) between studied groups:

Vessel density DCP flow (%)		Cases (n=24 eyes)	Control (n=24 eyes)	P
Whole retina		50.92±6.7	53.8±6.1	0.12
Superior hemi		50.20±7	53.87±6.5	0.12
Inferior hemi		51.06±6.5	53.18±5.8	0.14
Fovea		37.6±7.07	34.7±6.3	0.15
Parafovea	Parafovea whole	56.4±4.8	58.45±3.06	0.01*
	Superior hemi	56.93±4.5	59.22±3.6	0.06
	Inferior hemi	55.9±3.9	57.7±3.8	0.10
	Temporal	57.4±3.4	60.2±2.9	0.003*
	Superior	55.3±4.9	59.7±4.1	0.001*
	Nasal	56.7±3.9	58.7±3.6	0.06
	Inferior	55.2±4.5	58.3±4.5	0.02*
Perifovea	Perifovea whole	51.6±7.2	55.7±6	0.25
	Superior hemi	51.27±7.6	55.4±6	0.12
	Inferior hemi	52.03±7.1	56.04±5.47	0.03*
	Temporal	54.9±6.6	57.4±3.2	0.11
	Superior	50.8±7.7	54.2±6.8	0.11
	Nasal	51.2±7.9	54.9±7.1	0.09
	Inferior	50.27±7.4	55.4±5.9	0.01*

* significant at P <0.05

Table (3) RPC density, optic disc between studied groups.

RPC density, optic disc	Cases (n=24 eyes)	Control (n=24 eyes)	P
Whole	50.14±2.2	53.2±2.1	<0.001*
Inside disc	50.01±5.7	50.4±3	0.18
Peripapillary	50.3±2.4	53.3±2.1	<0.001*
Superior hemi	50.69±2.08	53.7±2.3	<0.001*
Inferior hemi	50.15±2.6	53±2.1	0.001*

*significant at P <0.05

Table (4) Vessel density SCP flow (%) before treatment and after 3 months of treatment among cases:

Vessel density SCP flow (%)		Pre treatment	After 3 months	P	
Whole retina		47.6±2.8	49.88±2.7	<0.001*	
Superior hemi		47.8±2.9	49.91±2.8	<0.001*	
Inferior hemi		47.4±2.8	49.29±2.6	<0.001*	
Fovea		20.07±6.1	20.5±6.3	0.54	
Parafovea	Parafovea whole	50.7±2.9	53.12±3	<0.001*	
	Superior hemi	51.05±3.2	53±3.3	<0.001*	
	Inferior hemi	50.4±3.3	53.31±3.34	<0.001*	
	Temporal	50.39±4.1	52.15±3.6	<0.001*	
	Superior	51.5±3.2	54.25±3.7	<0.001*	
	Nasal	48.6±3.1	51.9±3.3	<0.001*	
	Inferior	50.6±2.9	53.45±3.04	<0.001*	
	Perifovea	Perifovea whole	48.22±2.3	51.7±2.27	<0.001*
	Superior hemi	48.87±2.4	50.9±2.6	<0.001*	
Perifovea	Inferior hemi	48.15±2.3	52.4±2.7	<0.001*	
	Temporal	45.09±3.01	52.98±4.55	<0.001*	
	Superior	48.9±2.1	52.03±2.4	<0.001*	
	Nasal	53±2.3	55.2±2.7	<0.001*	
	Inferior	48.1±2.6	49.4±2.7	<0.001*	

* significant at P <0.05

Table (5) Vessel density DCP flow (%) before treatment and after 3 months of treatment among cases:

Vessel density DCP flow (%)		Pre treatment	After 3 months	P
Whole retina		50.92±6.7	53.90±6.5	<0.001*
Superior hemi		50.20±7	53.56±6.9	<0.001*
Inferior hemi		51.06±6.5	54.24±6.2	<0.001*
Fovea		37.6±7.07	39.2±8.1	0.001*
Parafovea	Parafovea whole	56.4±4.8	58.7±4.3	0.001*
	Superior hemi	56.93±4.5	59.9±4.9	0.002*
	Inferior hemi	55.9±3.9	57.8±4.3	0.001*
	Temporal	57.4±3.4	58.7±3.7	0.001*
	Superior	55.3±4.9	57±5	0.001*
	Nasal	56.7±3.9	57.2±4.08	0.002*
	Inferior	55.2±4.5	55.8±4.4	0.001*
	Perifovea	Perifovea whole	51.6±7.2	53.8±6.6
Superior hemi		51.27±7.6	54.1±6.9	0.01*
Inferior hemi		52.03±7.1	53.6±6.8	0.04*
Temporal		54.9±6.6	56.3±6.4	0.01*
Superior		50.8±7.7	53.5±6.9	<0.001*
Nasal		51.2±7.9	53.07±7.3	0.08
Inferior		50.27±7.4	51.7±6.6	0.19

Table (6) RPC density, optic disc before treatment and after 3 months of treatment among cases:

RPC density, optic disc	Pre treatment	After 3 months	P
Whole	50.14±2.2	51.13±1.7	0.32
Inside disc	50.01±5.7	53.4±5.7	<0.001*
Peripapillary	50.3±2.4	52.6±2.2	<0.001*
Superior hemi	50.69±2.08	52.7±2.1	<0.001*
Inferior hemi	50.15±2.6	52.5±2.1	<0.001*

* significant at P <0.05

Discussion

This study evaluated retinal vascular density using the OCT-A system in cases with IDA before and after 3 months of treatment.

The main results of this study were as follows:

The present study revealed that according to demographic data in the studied groups, the results were non-significant ($p > 0.05$), as the mean age of participants was 27 years with 83.3% females compared to 27.7 years with 41.7% among control. Also, the mean BCVA and IOP among cases was 1 and 13.5 respectively compared to 1 and 14.08 among controls.

By comparing the lab data between studied cases and control, it was exhibited that there was highly significant difference regarding Hb level 8.3 ± 1.05 g/dl (6-10), MCV 59.9 ± 5.3 μ g/dl (51-69), serum iron 14.5 ± 1.5 μ g/dl (12.1-16.7), TIBC 633.8 ± 30.9 μ g/dl (550-789) and ferritin 8.2 ± 3.2 μ g/L (3-12.5) ($P < 0.001$) as the means of all these parameters were significantly lower among studied cases than control, while the mean of TIBC was significantly higher among studied cases than control.

Regarding SCP VD, values were significantly lower ($P < 0.05$) in the IDA group compared to controls across all macular regions, including whole retina, sup-hemi, inf-hemi, parafovea (whole, sup-hemi, inf-hemi, temporal, superior, nasal, inferior), and perifovea (whole, sup-hemi, inf-hemi, temporal, superior, inferior). However, differences at the fovea and nasal perifovea were non-significant ($P > 0.05$).

In comparison between the IDA group and controls regarding DCP VD, no statistically significant differences ($P > 0.05$) were exhibited in the whole retina, sup-hemi, inf-hemi, fovea, parafovea (sup-hemi, inf-hemi, nasal), and perifovea (whole, sup-hemi, temporal, superior, nasal). While mean values across these regions were slightly lower with IDA, the foveal DCP VD was slightly higher with IDA, suggesting a degree of vascular adaptation in this region. This may reflect a protective mechanism in response to chronic systemic hypoxia, preserving perfusion in the fovea due to its elevated metabolic demands. On other hand, significant difference was exhibited regarding DCP VD in parafovea (whole, temporal, superior, inferior), perifovea (inferior hemi and inferior) ($P < 0.05$), as the means of all these parameters were significantly lower among studied cases than control.

Regarding the comparison of RPC density, optic disc whole image, peripapillary, superior hemi and inferior hemi between cases and control, the results were statistically significant ($P < 0.05$) as the means of these parameters were significantly lower among studied cases than control, while non-significant difference was exhibited regarding RPC density inside disc ($P > 0.05$).

Regarding structural parameters, RNFL and GCC thicknesses were exhibited to be significantly lower with IDA compared to the control group ($P < 0.05$), indicating retinal neurodegenerative changes associated with systemic iron deficiency.

In terms of hematological correlations, a positive significant association was

exhibited between SCP VD, DCP VD, RPC, RNFL, GCC and Hb, MCV, and serum iron. In contrast, TIBC demonstrated a negative significant correlation with these same parameters, highlighting its inverse relationship with retinal and optic nerve integrity in IDA.

Our findings are supported by the study conducted by Düzgün and colleagues., (2022) ^[3] who reported that SCP VD was significantly reduced with IDA in all parafoveal quadrants and in the whole image, except for the fovea, which remained non-significant ($P < 0.05$). However, they exhibited no significant difference in DCP VD across parafoveal sectors ($P > 0.05$), partially differing from our results. Interestingly, their data showed that foveal VD in both SCP and DCP was higher with IDA, though only DCP foveal VD reached significance ($P = 0.001$). Additionally, their study revealed a positive correlation between parafoveal SCP VD and hematologic indices including Hb, HCT, MCV, and MCH ($P < 0.01$), with no exhibited correlation at the fovea ($P > 0.05$). Furthermore, they noted a negative correlation between DCP foveal VD and MCV/MCH, and a positive correlation with RDW ($P < 0.05$).

Similarly, Koca and colleagues., (2022) ^[4] exhibited that SCP VD was significantly lower in all macular regions among IDA cases except for the fovea, supporting our findings. Their analysis of DCP VD revealed a significant decrease with IDA in all macular regions except the foveal zone. Regarding optic disc vascularity, RPC density inside the disc did not differ significantly between groups, which aligns with our results. However, peripapillary RPC VD was significantly reduced in IDA cases in the whole image, peripapillary zone, and superior hemi field ($P = 0.009$, 0.03 , 0.02 , respectively). Notably, although RNFL thickness was reported to be lower in their IDA group, the difference was non-significant, contrasting with our data. Their findings also showed a positive correlation between serum iron and SCP

VD ($P = 0.03$). However, they reported no correlation between TIBC and SCP, DCP, or RPC VD, diverging from our observations.

Further support comes from Cikmazkara & Ugurlu, (2016) ^[5] who demonstrated significantly thinner peripapillary RNFL in adult females with IDA. The mean RNFL was $94.67 \pm 9.38 \mu\text{m}$ in the IDA group compared to $100.22 \pm 9.12 \mu\text{m}$ in controls ($P = 0.001$). Significant thinning was exhibited in the temporal, nasal, and inferior quadrants ($P = 0.001$, 0.013 , 0.008 , respectively), while the superior quadrant showed no significant difference ($P = 0.114$). Additionally, no significant differences were exhibited between groups in optic disc parameters (rim area, disc area, or cup volume). They reported positive correlations between RNFL thickness and Hb, iron, ferritin, and transferrin saturation, and a negative correlation with TIBC. Their results also confirmed positive correlations between iron levels and VD in SCP, RPC, optic disc peripapillary zone, RNFL, and GCC, further aligning with our current findings.

Our results are consistent with those of Korkmaz and colleagues., (2020) ^[6] who reported a statistically significant decrease in SCP VD across all macular regions in IDA cases compared to controls ($P < 0.05$). In their analysis of the optic disc, they also exhibited significant differences in whole image, peripapillary, sup-hemi, and inf-hemi regions, while RPC VD inside the disc showed no significant difference—findings that align closely with our study. However, unlike our results, they reported no significant changes in DCP VD ($P > 0.05$). Their correlation analysis revealed positive associations between Hb, MCV, and both SCP and DCP flow, and a significant positive correlation between serum iron and SCP VD. Additionally, they documented negative correlations between TIBC and VD of SCP, DCP flow, optic disc whole image, RPC, and RNFL.

Similarly, Eltohamy, (2016)^[7] demonstrated significant reductions in RNFL thickness among anemic females when compared with healthy controls, using Topcon 3D OCT-2000. The IDA group showed thinner average, inferior, superior, nasal, and temporal RNFL sectors ($P < 0.05$). They also exhibited significant differences between groups regarding Hb ($P = 0.000017$), serum iron ($P = 0.00002$), and MCV ($P = 0.000173$), reinforcing the systemic impact of IDA on retinal structures.

Further support comes from a systematic review and meta-analysis by Ghasemi and colleagues., (2024)^[8] which concluded that IDA is significantly associated with reduced SCP VD in the whole retinal image (SMD = -1.12 , 95% CI: -1.85 to -0.39 ; $P = 0.001$, $I^2 = 83.15\%$). Their pooled analysis also revealed significantly lower RNFL thickness in IDA cases ($98.45 \pm 8.99 \mu\text{m}$) compared to controls ($105.44 \pm 11.41 \mu\text{m}$), with a 95% CI of -10.35 to -3.64 ($P = 0.001$, $I^2 = 92.56\%$).

Our findings are also in line with those of Kocer and colleagues., (2021)^[9] who evaluated RNFL and RPC vessel density (RPCvd) in IDA using OCT-A, comparing outcomes with age- and sex-matched controls. They exhibited significantly lower RPC VD in the whole image, peripapillary, sup-hemi, inf-hemi, inf-nasal, inf-temporal, and sup-nasal sectors ($P < 0.05$ for all) in IDA patients, whereas RPC VD inside the disc remained non-significant—findings that mirror our own. Numerous positive correlations were reported between RPC VD and hematologic indices such as Hb, HCT, MCV, MCH, MCHC, and ferritin. However, unlike our study, they exhibited no statistically significant differences in RNFL thickness between groups ($P > 0.05$).

In harmony, Mohanty and colleagues., (2022)^[10] also documented significant differences in average RNFL thickness and in the superior, inferior, and nasal quadrants, using SD-OCT, supporting the

notion that IDA contributes to structural thinning of the optic nerve fiber layers.

By comparing the lab data before treatment and after 3 months of treatment among studied cases, the results were highly significant ($P < 0.001$) as there was significant increase in hemoglobin (g/dl), MCV ($\mu\text{g/dl}$), serum iron ($\mu\text{g/dl}$) and ferritin ($\mu\text{g/L}$), while there was significant decrease in TIBC after 3 months of treatment.

By comparing SCP VD before and after 3 months of treatment among studied cases it was exhibited that, there was significant increase in SCP VD in all macular regions ($P < 0.05$) except fovea after 3 months of treatment ($P > 0.05$).

By comparing DCP VD before and after 3 months of treatment among studied cases it was shown that, there was significant increase in DCP VD in all macular regions ($P < 0.05$) except parafoveal (nasal & inferior) ($P > 0.05$), however, slight increase had occurred after 3 months of treatment.

By comparing RNFL and GCC before and after 3 months of treatment among studied cases it was exhibited that, there was significant increase in RNFLT and GCC after 3 months of treatment ($P < 0.05$).

Our findings are consistent with those of Çoban and colleagues., (2023)^[11], who reported that Hb, serum iron, and ferritin levels showed statistically significant increases both at 4–6 weeks and 12–16 weeks post-treatment ($P < 0.05$). Their study also demonstrated significant improvement in OCT-derived RNFL thickness—notably in total, inferior, nasal, and temporal quadrants—between baseline and the third follow-up visit ($P < 0.05$). However, no significant changes were exhibited in central macular thickness or superior RNFL thickness over the same period.

Similarly, Sinha and colleagues., (2012)^[12] exhibited a progressive increase in Hb levels in IDA cases, from 6.2 g/dL at baseline to 9.7 g/dL and 12.5 g/dL after 1 and 2 months of treatment, respectively (P

< 0.01). Their results also showed a significant rise in serum ferritin, from 7.0 µg/L to 153.1 µg/L and 279.1 µg/L over the same timeline ($P < 0.01$), reinforcing the positive hematologic response to iron therapy.

Conclusion

Retinal changes induced by IDA, including reductions in macular and optic disc vessel density, appear to be reversible with iron treatments. Improvements in SCP VD, DCP VD, RPC, RNFL, and GCC were exhibited following therapy, reflecting a restoration of retinal perfusion. OCTA may serve as a sensitive, non-invasive imaging modality capable of detecting retinal ischemia before the onset of clinically evident retinopathy in IDA. Moreover, haemoglobin level and serum iron level, may act as potential predictive biomarkers for vascular impairment in these cases. Large-scale studies are warranted to explore the clinical implications and pathophysiologic significance of OCTA-measured VD reductions in anemia-associated retinal dysfunction.

Conflict of interest

None of the contributors declared any conflict of interest

Recommendation

- Future studies with larger sample sizes and extended follow-up durations are essential to validate and expand upon the current findings.
- It is advised that future research utilize randomized controlled trials (RCTs) or large-scale comparative observational studies to enhance evidence quality.
- Multicenter studies are recommended to increase generalizability and confirm the reproducibility of results across different populations and clinical settings.

Limitations:

The sample size was relatively small.

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